

## VIKING PACEMAKER OPERATING MANUAL

### A. SET UP INSTRUCTIONS FOR FACTORY WIRED TRANSMITTERS

- 1 After unpacking the transmitter, inspect thoroughly for any possible damage from shipping. Claims against the carrier delivering the equipment must be made to the carrier agent at the point of delivery. DO NOT SHIP DAMAGED EQUIPMENT BACK TO MANUFACTURER UNTIL NOTIFIED TO DO SO BY THE MANUFACTURER. NOTIFY THE SERVICE DIVISION THAT A CLAIM IS BEING MADE AGAINST THE CARRIER.
- 2 Remove the packages containing the knobs and the three plugs: The four pin plug, P1; the nine pin plug, P2; and the small two pin plug, P4.
- 3 Install knob as follows (setscrew for knob may be packed separately and can be installed at time of mounting)
  - a. Install the large 2 3/8" knob, using one 10-32 setscrew, on the 1/4" shaft extending from the VFO planetary drive. The four fingered tension spring should be placed between the knob and the dial pointer with the fingers toward the knob. The spring should be slightly compressed. Tighten the setscrew.
  - b. At this time, check the function of each knob to see if the indexing agrees with the markings on the panel (i.e. BAND switch on 80 meters when counter-clockwise and 10 meters when fully clockwise).
- 4 At this time, refer to Section E of the Operating Manual, in order to determine if there has been an appreciable change in the calibration of the VFO due to rough handling in shipment. It is doubtful that any deviation will occur when changing from one set of tubes to another in the VFO, since circuit design considerations guard against normal internal variances in the tubes. Occasional spot checks on both the 80 and 10 meter bands against a frequency standard of reputable calibration accuracy will verify the VFO calibration accuracy. If the calibration is not accurate, proceed to recalibrate as directed in Section E.
- 5 Read sections B, Theory of Operation; Section C, Tuning Procedure; and Section D, Pi Network Tuning and Harmonic Suppression, in order to gain familiarity with the equipment before continuing tuneup.
- 6 Tune the transmitter up on all bands 80 through 10 meters following the procedure outlined in section C, checking for adequate grid drive and proper loading and operation on all bands.

### B. JOHNSON VIKING PACEMAKER THEORY OF OPERATION

#### 1 GENERAL THEORY OF OPERATION

The basic scheme of the Viking Pacemaker employs the phasing method of obtaining Single Sideband. As seen from the block diagram in Figure 10, the basic frequency determining elements are a crystal oscillator, with a different crystal for each amateur band, and a stable low frequency VFO. The audio is fed through proper amplification and phasing networks to a balanced modulator where it is combined with a correctly phased rf source generated by a crystal oscillator. This circuit yields single sideband suppressed carrier which is nominally at the crystal frequency. The SSB at this frequency is then heterodyned with a frequency from the VFO in a mixer stage, to produce the desired output frequency. This SSB signal, which is now at the desired output frequency, is then amplified and fed to the antenna. The frequency scheme is unique in the amateur field in that the SSB is generated at a different frequency on each amateur band. This frequency, as mentioned previously, is crystal controlled at 500 kc, 4 mc., 11 mc., 18 mc., and 25 mc. for the 80, 40, 20, 15 and 10 meter bands respectively. The VFO operates in the range 3 mc. to 3.5 mc. for the first four bands, and in the range 3 mc. to

- B. 1 4.7 mc on 10 meters. For instance, on 80 meters, by mixing the 500 kc crystal and the 3 mc to 3.5 mc VFO, the output frequencies obtained will vary from 3.5 mc to 4 mc., i.e., the sum of the two oscillator frequencies.

## 2. DETAILED DESCRIPTION OF BASIC CIRCUITS

### a. Variable Frequency Oscillator

The Variable Frequency Oscillator is patterned after the other famous Johnson VFO's in that it employs the series tuned Colpitts circuit. Two separate tank circuits are employed, one on the bands 80 through 15 meters, and the other on the 10 meter band. The first tuned circuit covers the range 3000 kc to 3500 kc and the other tuned circuit covers the range 3000 to 4700 kc. The VFO tuned circuits are controlled by an internal VFO switch which is mechanically linked with the main bandswitch insuring the proper VFO output frequency for the band selected. The VFO utilizes a 6AU6 tube, the plate circuit of which contains an rf choke which is self resonant at about 4 mc. thus providing a broadly tuned circuit which affords a measure of attenuation to undesired harmonics as well as supplying a reasonable constant output voltage. The plate circuit of the VFO also contains a low pass filter which has a cutoff at about 5 mc. This low pass filter provides considerable attenuation to any second harmonic voltage which might be generated in the VFO and which might tend to degrade the quality of the output signal.

A high degree of stability is insured by proper circuit design, rigid construction, temperature compensation and voltage regulation. Additional circuit design considerations eliminate any interaction between the oscillator stage and succeeding stages in the RF section. An auxiliary series coil and a variable capacitor are employed on each band to permit careful calibration of each VFO to the dial scales.

### b. Crystal Oscillator and Cathode Follower Output Stages

The crystal controlled frequency used for generating the SSB on each band is obtained from a stable crystal oscillator stage which employs a 6AU6 tube. The circuit is the standard tuned grid, tuned plate circuit with additional feedback being employed to provide reliable operation of the circuit. The grid of the 6AU6 is switched to a different crystal for each band, as explained previously, with the crystal providing the tuned circuit for the grid of the oscillator. The plate circuit of the crystal oscillator stage is also switched to a different tuned circuit for each band. The individual tuned circuits are composed of fixed capacitors and variable inductances which have been chosen to supply proper operating Q for each of the frequencies involved. All switching, both in the grid and plate circuits is mechanically linked to the main bandswitch knob through a reliable dial cord drive so that the correct tuned circuit and crystal are automatically selected on each band.

The output of the crystal oscillator is coupled to a 12BH7 Cathode Follower stage which is used primarily as an impedance transformer to couple the high impedance of the crystal oscillator to the low impedance RF phase shift networks. The RF phase shift networks are a resistance-inductance network and a resistance-capacitance network which provide a leading 45 degree voltage and a lagging 45 degree voltage, respectively. This network employs two precision resistors and has inductances and capacitances which are switched on the various bands to provide the proper RF phase shift to the particular crystal frequency in use on that band. The RF phase shift network provides two outputs which are 90° out of phase with each other. These are subsequently fed to the balanced modulator stages which are explained in paragraph e below.

### c. Audio Circuits

The Johnson Viking Pacemaker transmitter is designed to operate from any high

b. 2. c. impedance microphone. The audio is fed through a two pin microphone jack which has provision for push to talk, to the first audio amplifier which employs a twin triode 12AX7 tube. This stage furnishes sufficient amplification to drive the Audio Output stage which is one triode section of a 12AU7 tube. This tube is transformer coupled to a low pass filter. The transformer performs the dual function of providing a means of obtaining push-pull audio from the single ended audio, obtained from the tube, and also to provide a means of furnishing an impedance transformation from the high impedance plate circuit of the audio output tube to the low impedance input of the low pass filter. The low pass filter is a balanced pi network designed to cut off at about 3500 cycles. This provides an audio signal with a restricted bandwidth to the input of the phase shift network which follows the low pass filter. The audio phase shift network provides a very nearly constant 90 degree shift to the audio voltage over the range 300 to 3000 cycles. A detailed explanation of the manner in which the audio phase shift network functions will be omitted since most of the current literature has reference to phase shift networks of this type. The output of the audio phase shift network is two phases of audio which are equal in magnitude and 90 degrees apart in phase.

d. **Audio Phase Inverter Stage**

The two audio voltages obtained from the phase shift network are applied to the grids of an audio phase inverter stage which employs a dual triode 12AT7 tube. The output is taken from the two plate and two cathode leads. The plate and cathode of each triode section supply signals which have a  $180^\circ$  relationship with each other. The two tubes are  $90^\circ$  out of phase with each other so that the output of the phase inverter is actually four phases of audio  $90^\circ$  out of phase with each other.

e. **Balanced Modulator Stages**

The balanced modulator circuit, which is the heart of most phasing type single sideband excitors, is composed of two ECC-81 tubes. Each tube contains two triode sections so that the balanced modulator stages contain four triode sections in all. Each of the two tubes has its plates connected in push-pull to a balanced push-pull tuned tank circuit. This circuit is switched by means of the main bandswitch, and is tuned by a front panel control so that it may be resonated to the crystal frequency involved on the band in use. The grids of the balanced modulator tubes have two types of signals applied, one is the audio, and the other is RF from the RF phase shift networks. One phase of RF is fed to both grids of one of the ECC-81 balanced modulator stages, and the other phase of RF from the RF phase shift networks. One phase of RF is fed to both grids of one of the ECC-81 balanced modulator stages, and the other phase of RF from the RF phase shift network, which is  $90^\circ$  away in phase from the first one, is fed to the grids of the other ECC-81 balanced modulator tube. Both grids of each tube are tied together with respect to their respective RF signals. Since the grids of each tube are excited in parallel, the plates are tied in push-pull, the carrier, or RF, is balanced out in the plate circuits thus providing suppressed carrier operation.

The four phases of audio which are obtained from the Audio Phase Inverter as explained in paragraph d., are applied separately to the four grids of the two balanced modulator tubes. Each tube has its grids excited  $180^\circ$  degrees out of phase with each other. This combination of RF and audio combines to yield a Single Sideband Suppressed Carrier signal.

The carrier suppression is adjustable by means of potentiometer controls from the front panel. These controls compensate for the individual triode variances in each tube. Another control, R33, the CHANNEL BALANCE, which is located within the cabinet is used to compensate for variances between tubes. This control need be adjusted only when one of the tubes is changed.

R. 2. f RF Exciter Stages

The RF exciter portion of the transmitter is composed of three tubes, a 6BE6 mixer, a 6AU6 amplifier and a 6CL6 driver tube. The 6BE6 stage converts the crystal frequency SSB and the VFO frequency into the desired operating frequency. The plate circuit of the mixer contains the sum and difference frequencies and the two applied frequencies. However, since the circuit is tuned to the sum of the two frequencies, some selectivity or attenuation is realized to the other frequencies. The output of the mixer tube is applied to the grid of the 6AU6 tube. The plate of the 6AU6 amplifier tube is also tuned to the same frequency as the mixer plate circuit thus realizing more attenuation to the undesired frequencies which are generated in the mixer tube. The grid of the 6AU6 is grid block keyed for CW operation and also when operating the transmitter in push-to-talk or voice-operate operation. The output of the 6AU6 tube is coupled to the 6CL6 driver tube. The output of the 6CL6 contains a third tuned circuit which is tuned to the desired frequency and which couples the desired signal into the grid of the Power Amplifier tube. Each of the foregoing tuned circuits is switched by the main bandswitch, SW3, so that proper band operation is insured. The circuits are further tuned to the desired operating frequency by a gang tuned capacitor which is controlled from the front panel and is designated EXCITER tuning. The three tuned circuits in cascade provide sufficient attenuation to any undesired frequencies to provide a clean signal at the grid of the Power Amplifier.

g. Power Amplifier

The Power Amplifier stage employs a 6146 tube which is operated as a class AB<sub>1</sub> amplifier. The grid is excited from the 6CL6 driver stage. The output is a pi network tank circuit utilizing a hi Q inductor which is switched by the main bandswitch SW8 to provide proper operating Q on each of the amateur bands. The loading control has both a fine and coarse control to provide for matching wide ranges of load impedances. The grid of the Power Amplifier is also grid block keyed to turn the transmitter on or off in the various types of emission, and to key it in CW operation.

h. Voice Operate and Anti-Trip Circuits

Built-in VOX operation is provided for in the Viking Pacemaker transmitter by a 12AT7 VOX amplifier and 6AL5 rectifier tube. The audio signal is coupled from the plate of the first audio amplifier to the grid of the VOX amplifier tube. The audio is amplified and then rectified by half of the dual diode VOX rectifier tube. The rectified audio is applied as DC to the grid of one half of a 12AT7, the VOX relay amplifier tube. Whenever audio is present at the microphone input, the rectified DC applies a positive voltage to the grid of the relay amplifier tube thus causing the tube to conduct and close the VOX relay. The VOX relay has four sets of double throw contacts. One set is used to key the transmitter, the second set is used to provide voltage to operate an antenna relay. A third set is wired to the external control plug to provide a set of SPDT contacts to be used for any function necessary, e.g. biasing of an external high power amplifier. The fourth set is connected to the Receiver Control plug, J2, and may be used to mute or "standby" the receiver.

An additional feature which incorporated in the Viking Pacemaker transmitter is the Anti-Trip circuit which prevents speaker audio (which enters the station microphone) from operating VOX circuits. This is accomplished by the use of the other half of the audio output 12AU7. Audio from the receiver output is applied through the receiver control plug to the grid of the Anti-Trip amplifier. The output of this amplifier is rectified in the other half of the 6AL5 and provides a negative voltage which is applied to the VOX relay amplifier grid. This negative voltage

- B. 2 h. counteracts the positive voltage which is present due to the rectification of the speaker audio which has entered the system through the microphone.

This prevents the speaker audio from energizing the VOX circuits since it applies both a positive and negative voltage to the VOX relay tube grid which cancel each other out. Suitable time constant circuits are employed which provide a fast operate and a slow release time on the Voice Operate relay.

i. Power Supply

The Viking Pacemaker transmitter utilizes three power supplies: A low voltage supply which supplies the audio, balanced modulator control and RF exciter voltages as well as the two oscillators; a high voltage supply for the plate circuit of the Power Amplifier; and a regulated bias supply which is used for keying purposes and for balancing control functions in the RF and audio circuits.

The low voltage rectifier tube is the rugged 5U4G low voltage high current rectifier which provides 300 volts at 225 ma of current. The high voltage is obtained from a 5R4GY tube which provides 750 volts at 120 ma of current for the Power Amplifier tube. The bias supply rectifier is a 6X4 which has no current drain other than the bleeder and keyer network. The bias supply is a nominal 200 volt supply which is dropped to 150 volts (regulated) through suitable resistors and an OA2 voltage regulator.

j. Control Circuits

The control circuits of the Pacemaker transmitter may be divided into four basic sections. Refer to the Simplifier Control Circuit schematic, Figure 11.

- (1) Keying Network: The Pacemaker uses grid block keying to provide exceptionally fine CW operation. The grid block bias is also used to energize the RF circuits in the AM and SSB positions.

The keying network is composed of several resistors and capacitors and is integrated with the MODE and OPERATE switch to provide proper operation under all combinations of these switches. As seen from the Simplified schematic, the 150 volt bias voltage is used in a type of divider network. For purpose of explanation assume CW operation. In CW, the switch SW1A, rear, will connect the key jack to the key line through terminals 1 and 2. The bottom end of R77 and R74 are tied together through terminals 3 and 4 of SW2B, rear.

When the key is closed, the bottom ends of the two resistors are grounded. Under this condition the -150 volts is divided down to supply -65 volts to the 6146 grid and -1 volt to the 6AU6 amplifier grid and 6BE6 mixer grid thus allowing them to operate correctly. Proper rounding of the front end of the wave form when the key is depressed is provided by the discharge of C173 through R74. When the key is released, the two capacitors C173 and C160 must charge thus providing proper shaping of the back of the wave form.

Two variations of this sequence are used when in the other MODES of operation. The VOX relay performs the function of grounding the key line through terminals 1 and 2 of SW1A rear. The key is disabled by the same switch at terminals 1 and 2.

Regardless of what position the MODE switch is in, when the OPERATE switch is turned to the ZERO position the Final Amplifier is automatically biased off and the second RF Amplifier is keyed to provide a signal to the grid of the Final. This is accomplished by terminals 3 and 4 of SW2B, rear, which removes

- B 2 j. (1) R77 from the key line and terminals 1 and 4 of SW2B, front, which ground the key line. As an added feature, the VOX relay amplifier tube grid is grounded through terminals 1 and 12 of SW2B front thus preventing the VOX relay from operating and removing the antenna from the receiver. This feature allows one to "talk himself on frequency" while listening to the other station he is attempting to "Zero".
- (2) VOX Relay Amplifier: Another section of the control circuits deals with the VOX Relay Amplifier tube. As mentioned previously, the VOX Relay tube grid is grounded in ZERO position to prevent voice operation of the antenna relay circuits in the ZERO position. The same is true of the STANDBY position thus preventing operation of the transmitter while in STANDBY.

Push-to-Talk operation of the transmitter is accomplished by grounding the cathode of the VOX Relay Amplifier tube thus removing the fixed cathode bias supplied by B+ through the voltage divider of R55 and R54. The PTT feature is available when the OPERATE switch is in the VOX PTT position but is disabled through terminals 7 and 6 of SW2B front in all other positions of the OPERATE switch.

- (3) Carrier Insert and Audio Disabling: Carrier Insertion for CW, AM and ZERO operation is provided by applying positive voltage to one of the Balanced Modulator tube grids through a resistor divider network composed of R86 and R76 through isolating resistor R87. The control lead to R87 is grounded when the MODE switch is in the SSB positions and the OPERATE switch is in any position other than ZERO. Under this condition, if the BALANCE controls have been properly set, the carrier will be suppressed. If the OPERATE switch is put in the ZERO position the path to ground is broken by terminals 1 and 12 of SW2A rear thus placing positive voltage on the Balanced Modulator grid. This unbalances the system and supplies a carrier. The same path to ground is broken if the MODE switch is not in the SB positions thus supplying carrier in the AM and CW modes.

Terminals 5, 11 and 12 of SW1B, front, short the primary of the audio output transformer T1 in the AM-HI and CW positions thus preventing audio from appearing in the output in these modes of operation.

- (4) 115 Volt AC Control Circuits: The primary 115 volt AC voltage is supplied through terminals 3 and 4 of SW2A front to energize the transmitter when the operate switch is rotated from the OFF position.

A 115 volt control voltage is available at the rear of the transmitter through a two pin jack, J4. This voltage is applied through a normally open set of contacts on the VOX relay which are closed when the relay is energized either by VOX, PTT or MAN-CW operation. It may be used for an antenna relay or other control functions.

Another 115 volt lead is available at pin 8 of the external control plug J3. This lead is used when the Pacemaker is used in conjunction with the Viking Kilowatt. It provides one side of the AC line and is hot at all times when the Pacemaker is in the SB or AM-LO position and is hot only when the VOX Relay is energized when in the AM-HI and CW positions. This is used to energize the Plate contactor of the Viking Kilowatt through terminals 3, 4 and 9 of SW1A, front. The plate contactor of the Kilowatt is then energized at all times in the SB and AM-LO positions, but in the AM-HI & CW positions the contactor is energized only when the VOX Relay is energized.

AM-LO and AM-HI have no reference to LO sideband and HI sideband. AM-LO actually refers to single sideband AM, low level AM, so to speak. It is carrier and the lower

- B. sideband. AM-III is used when one desired to run conventional double sideband AM to a high powered class C final amplifier. The Pacemaker does not supply the AM; however, when in the AM-HI position, 60 watts of unmodulated R.F. output is available at any frequency in the amateur bands to be used as excitation for the Class C, AM final. Approximately .5 volts of audio is also available at the rear of the Pacemaker. This audio may be used to drive an intermediate audio amplifier driver such as the Johnson Audio Amplifier, 250-33, which in turn drives the high powered modulators for the final amplifier.

### C. VIKING PACEMAKER TUNING PROCEDURE

1. **NOTICE:** The regulations of the Federal Communications Commission require a suitable license for operation of this equipment. Refer to publications of the Federal Communications Commission or the American Radio Relay League for the latest rules governing station and operator licensing.

Be sure to return the enclosed warranty registration card. This will register your transmitter at the factory. If it becomes necessary to write to the factory regarding your transmitter, refer to it by serial number.

The tuning procedure of the Viking Pacemaker is identical on all bands of operation, 80 through 10 meters. For this reason a discussion of tuning procedure for one band will apply to all bands. The dial and switch settings will change when going from one band to another, of course.

### 2. BASIC TUNING PROCEDURE

To simplify the tuning and loading of the Pacemaker, a basic tuning procedure will be developed. All modes of operation require that the transmitter first be tuned in accordance with this basic procedure. This basic tuning procedure is accomplished in the AM-HI mode. All other modes require the same preliminary adjustments. Variations of the basic procedure will then be introduced to cover the SSB (SB1 and SB2), AM-LO and CW modes.

It is suggested that the tuning be tried on a dummy antenna until one gains familiarity with the controls. A 75 to 100 watt light bulb or standard 52 ohm non-inductive load of 75 watt capacity or more should be used for a dummy load. For purposes of illustration the transmitter will be tuned at 3.8 mc on 75 meters.

- a. Turn OPERATE switch to OFF.
- b. Connect the dummy load to the antenna jack, J6, on the rear of the transmitter.
- c. Set knobs to the settings given below. Those knobs which are not mentioned are not critical in the basic tuning procedure.
  1. OPERATE switch to STANDBY.
  2. CARRIER INSERT to "4".
  3. METER switch to PLATE.
  4. MODE switch to AM HI.
  5. BAND switch to desired band (80).
  6. AUX and FINE COUPLING controls to "4" and "0" respectively.
  7. CARRIER BALANCE controls to "5".
  8. VFO to desired frequency (3.8 mc).
- d. OPERATE switch to MAN-CW.
- e. Adjust BAL MOD tuning and EXCITER tuning controls for a peak reading on the meter.
- f. IMMEDIATELY adjust the FINAL tuning control for a plate current dip.
- g. METER switch to GRID.
- h. Advance CARRIER INSERT control to obtain at least 0.2 milliamperes of grid current (two small dial divisions on the meter).

- C. 2. i. Carefully re-adjust the BAL MOD tuning and EXCITER tuning for a peak grid current reading.

The EXCITER tuning control is tracked to cover the entire amateur band on each transmitter band with the dial reading increasing from "0" to "100" as the frequency is increased. See page 26 for discussion of EXCITER tuning and frequency coverage.

#### NOTE

The BALANCE MOD control need not be readjusted unless the transmitter is switched to another band.

- j. Adjust CARRIER INSERT to obtain 0.2 ma of grid current again (if grid current cannot be reduced to 0.2 ma, it may be necessary to adjust the CARRIER BALANCE controls to bring it within range of the CARRIER INSERT control).
- k. METER switch to PLATE.
- l. Adjust FINAL tuning control for a plate current dip. Increase the FINE and AUX loading controls as required, always maintaining plate current dip with the FINAL tuning control until the plate current indicates 115 millamps on the meter (with 0.2 ma grid current).

#### NOTE

It is important in any of the tuning procedures that this Basic Tuning Procedure be used and that the transmitter be tuned and loaded in every case to 0.2 ma of grid current and 115 ma of plate current first.

### 3. TUNING PROCEDURE FOR SINGLE SIDEBAND

- a. Check to see that a microphone is connected to the microphone jack, J1, on the rear of the transmitter. Pin 1 of the connector should be connected to the audio line of the microphone. The shield of the mike cable should be grounded. Pin 2 of the mike connector is for push-to-talk and should be connected to the microphone push-to-talk switch if there is one.
- b. Tune up transmitter as in basic tuning procedure step 2, above.
- c. MODE switch to SB1, upper sideband or SB2, lower sideband.
- d. METER switch to PLATE.
- e. Adjust CARRIER BALANCE controls for minimum plate current as indicated on the meter. This should be about 15 to 20 ma. If the idling current is much different than this, refer to section E, paragraph 8, for adjustment procedures.
- f. METER switch to GRID.
- g. Advance AUDIO gain control while speaking into the microphone until small peaks of grid current are indicated on the meter on voice peaks. The grid current should not exceed 0.1 ma. (one small dial division) More audio gain will tend to degrade the quality of the signal. Average voices will indicate about 55 to 60 ma peaks on the plate current meter.

### 4. TUNING PROCEDURE FOR AM LO

- a. Connect microphone as indicated in step 3a above.
- b. Tune up the transmitter as in the basic tuning procedure step 2, above.
- c. MODE switch to AM-LO.
- d. METER switch to PLATE.

- C. 6. b. relay and the transmitter in all modes of operation. The transmitter is de-energized by rotating to the STANDBY position. When the switch is in the MAN-CW position 115 VAC is available at J4 to operate an antenna relay.

To operate complete break-in CW, the switch should be left in the MAN-CW position and a TR box or a separate receiving and transmitting antenna used.

c. ZERO

Direct zero-beating of a station is provided for in the ZERO position of the OPERATE switch. This position keys the RF exciter but not the final amplifier. The antenna relay is also not energized. If the CARRIER INSERT control is in a position other than "0", a signal will be available for zero-beating purposes in all positions of the MODE switch. As a further convenience, in the SB position one may zero-beat by "talking himself onto frequency". In this case the CARRIER INSERT control may even be on "0". In some well shielded installations it may be necessary to provide additional coupling from the Pacemaker to the receiver when attempting to ZERO on the lower frequency bands. This can be accomplished by coupling a small piece of insulated wire to the receiver antenna terminal and inserting the other end of the wire through the bottom of the Pacemaker cabinet into the 6CL6 plate circuit compartment. Use care to avoid shorting any components with the wire.

## 7. AUXILIARY HIGH POWER AMPLIFIERS

Although the Viking Pacemaker is designed to provide adequate power to "hold its own" in the crowded amateur bands, facilities are also provided to permit it to be used to drive a high power linear amplifier, or in the case of AM-HI operation, a high power conventional plate modulated amplifier. The Viking Kilowatt combined with the Pacemaker, Audio Amplifier and Power Divider provide an excellent combination for running the legal limit in power under AM, CW or SSB.

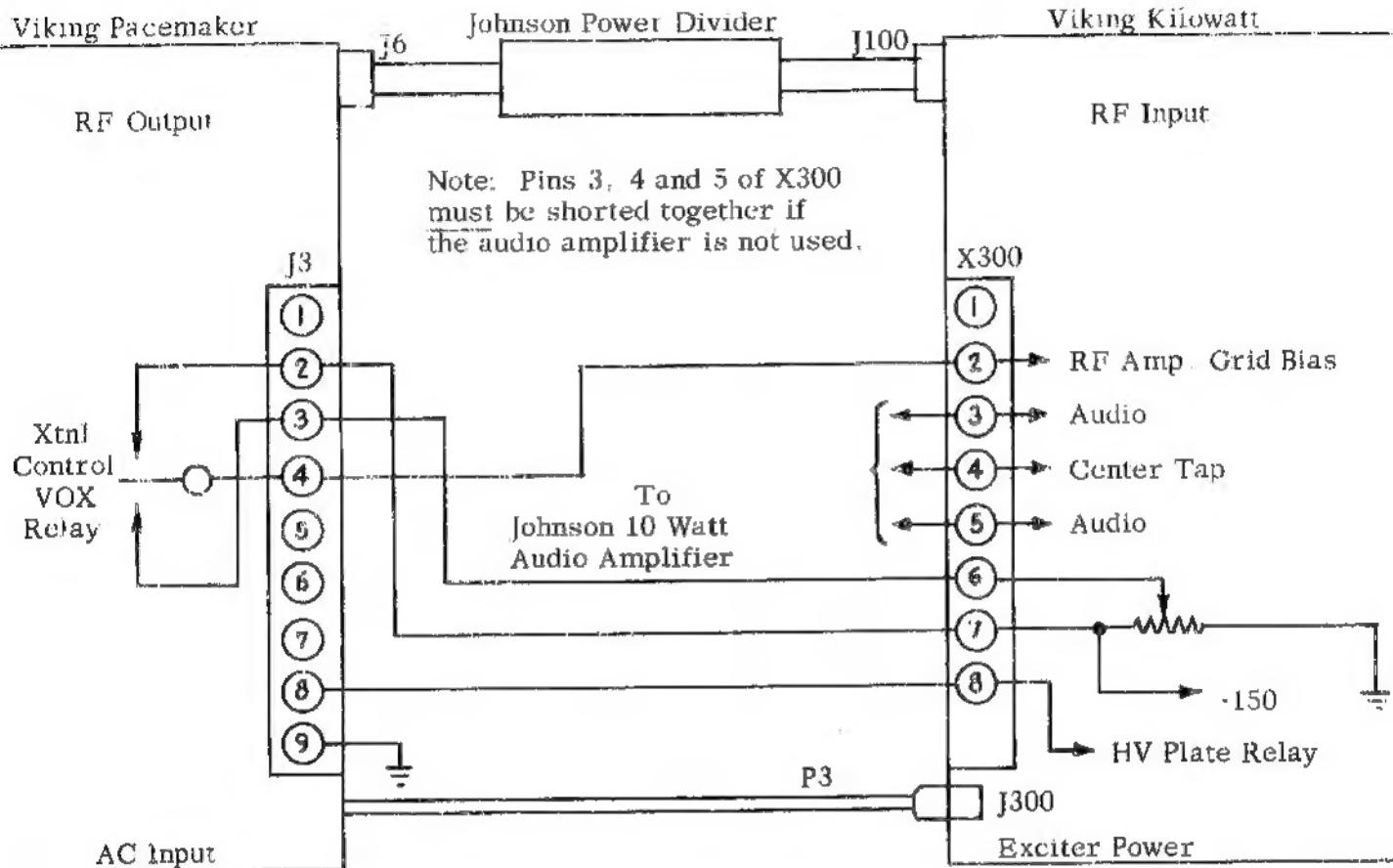
a. High Power Linear Amplifier

The Pacemaker can drive most high powered linear amplifiers in AM-LO, CW and SSB operation. The following connections will be required between the Pacemaker and the Linear Amplifier:

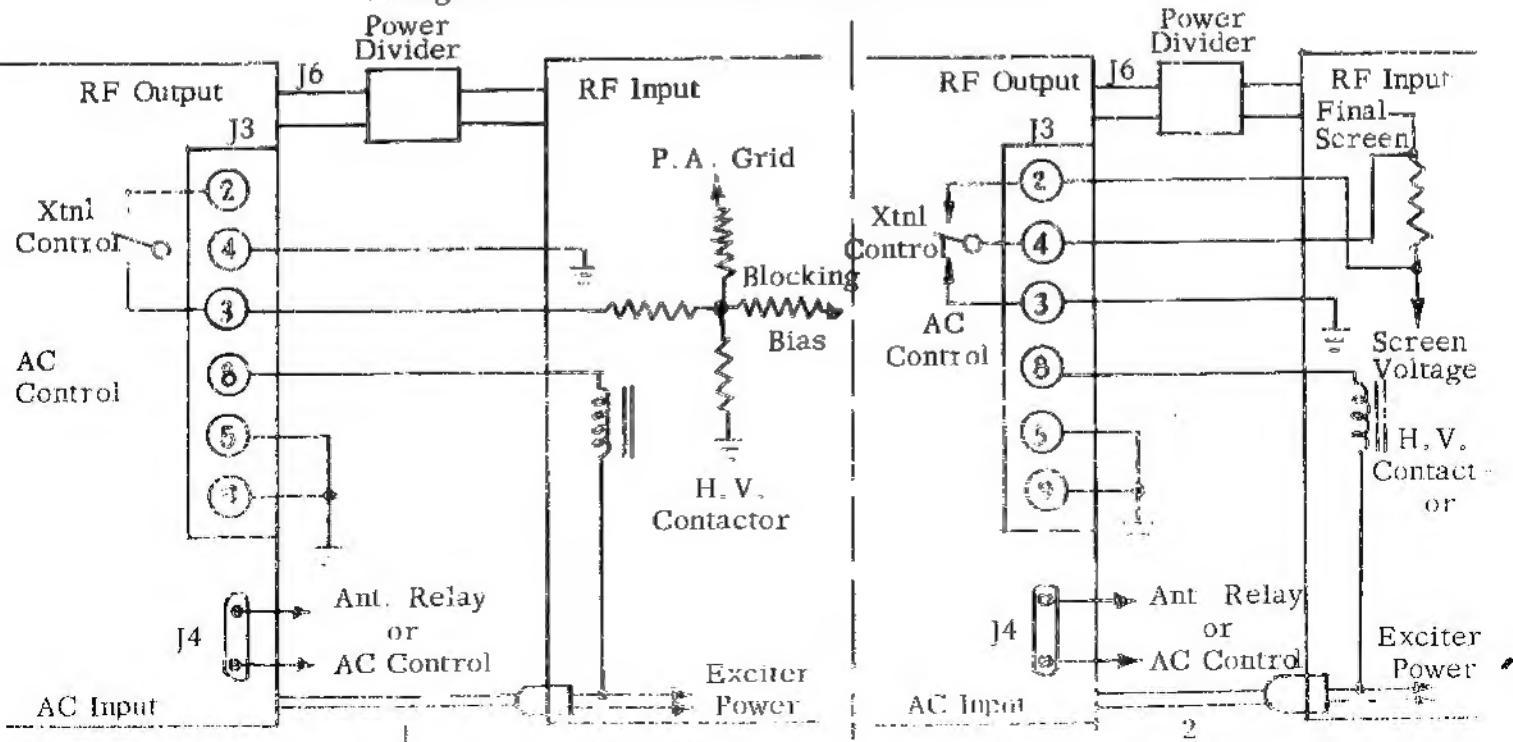
- (1) An RF coaxial cable from the output of the Pacemaker, Jack J6, to the input of the linear amplifier. A power divider will be required in most installations since most linear amplifiers require only a few watts of drive while the Pacemaker delivers 60 watts P.E.P. The Pacemaker should always be operated at its full input in the SSB and AM-LO modes to preserve the best signal to noise ratio. The reasons for this are explained on page 26. The Johnson 250-34 Power Divider is suitable for this purpose. The Power Divider provides adequate control of the drive to most Power Amplifiers in the SSB and AM-LO positions, however, it may be necessary when using CW or AM-HI, in conjunction with a high power final, to reduce the output of the Pacemaker by retarding the CARRIER INSERT control to obtain specified grid drive of the final amplifier.
- (2) Several control functions are available to energize and disable the linear amplifier. The one to be used will be dependent upon the type of amplifier used.
  - a. A set of single pole, double throw, relay contacts is available at pins 2, 3 and 4 of J3. These contacts are switched when the VOX relay is energized. They may be used to control the External amplifier bias or perhaps its screen voltage, to disable the amplifier in standby periods
  - b. 115 volts AC is available at the antenna relay jack, J4, when the VOX relay is energized. This may be used to control any AC functions in the external amplifier if a TR box is used, or may be used to operate the antenna relay

C 7 1 (2) : One side of the 115 volt AC line is available at pin 8 of J3 under the following two conditions: (1) In the SBI, SB2 and AM LO conditions at all times except in the OFF position of the OPERATE switch, and (2) In the AM HI and CW positions only when the VOX relay is energized.

It is suggested that the amateur use the combination of functions which suit his particular station set up. The sketch below indicates the manner in which the Johnson Viking Kilowatt should be interconnected with the Pacemaker. Two other typical installations are also shown:



#### Viking Kilowatt and Pacemaker Interconnections



## TYPICAL PACEMAKER AND HIGH POWER LINEAR INTERCONNECTIONS

### b. High Power Conventional Class C CW or Plate Modulated Final Amplifier

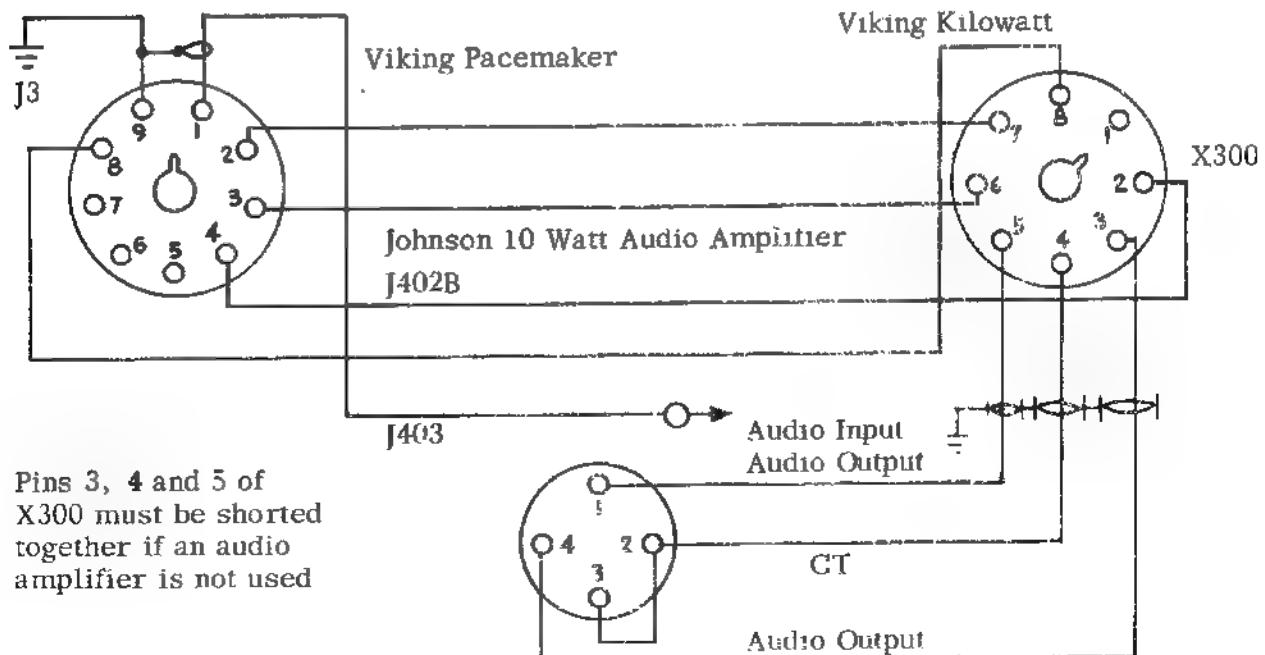
The Johnson Viking Pacemaker is designed to operate with conventional Class C CW or Plate Modulated Final Amplifiers to provide the maximum legal input power in all modes of operation. With the normal 2 ma of Pacemaker grid current, the Pacemaker loading controls should be adjusted to obtain 115 ma of plate current. The CARRIER INSERT control should then be adjusted for the required amount of grid drive to the final amplifier.

#### (1) CW Operation

- a. To drive a conventional Class C high powered Final Amplifier it is merely necessary to operate the Pacemaker in its normal CW mode. A coaxial cable will be required to furnish the RF drive from the Pacemaker output to the high powered final input. A Power Reducer or Divider may or may not be required depending on the drive requirements of the external final amplifier. Pin 8 of J3 may be used to obtain one side of the 115 volt AC line which may be used to operate the external final amplifier high voltage plate contactor. It will be necessary to use proper polarization of the Pacemaker plug. This will provide an AC control voltage which will operate the plate contactor when the Pacemaker OPERATE switch is turned to MAN CW, and which will de energize it when the Pacemaker OPERATE switch is turned to STANDBY. The antenna relay jack, J4, of the Pacemaker may be used to operate the antenna relay if required.

#### (2) High Powered Plate Modulated Final Amplifiers

The Pacemaker has provisions for operating high power plate modulated final amplifiers when used with an external audio amplifier which will supply the required audio power to drive the final high powered modulator. The Pacemaker supplies approximately .5 volts of audio at Pin 1 of J3 which may be used to drive an intermediate audio amplifier which in turn may drive the high powered modulator. The Johnson 250-33 Audio Amplifier is suitable for modulators which require about 10 watts of drive. See figure below for typical installation.



## VIKING PACEMAKER, KILOWATT AND AUDIO AMPLIFIER INTERCONNECTIONS

- i Connect the RF output jack, J6, of the Pacemaker to the input of the external amplifier through a suitable coaxial cable assembly and power reducer or divider if it is required.
- i Pin 8 of J3 may be used to obtain an AC control voltage which may be used to operate the plate contactor in the external amplifier. See paragraph B 1a, above. The connection is required when the Johnson Viking Kilowatt is to be used.
- i Connect the insulated lead of a shielded lead to Pin 1 of J3 and the shield to Pin 9 of J3. Connect the other end of the shielded lead to the input of the external audio amplifier. Connect the output of the audio amplifier to the input of the external high powered modulator.
- i The antenna relay jack J4 of the Pacemaker may be used to operate the antenna relay. Any of the other external control functions which are available (See paragraph A 2 above) may also be used as needed.
- i The microphone is then connected to the Pacemaker microphone connector.
- g Tune and load the transmitter in the AM-HI position just as in CW. It is recommended that the VOX feature be disabled (by rotating the VOX gain control to the furthest counter-clockwise direction) so as not to put undue stress on the external plate contactor.

## 8 ANTI-TRIP CIRCUITS AND RECEIVER MUTING

As mentioned previously, an anti-trip circuit is incorporated to prevent speaker audio from activating the transmitter. Facilities are also provided to mute or "standby" the receiver. These functions are available at the receiver control plug J2.

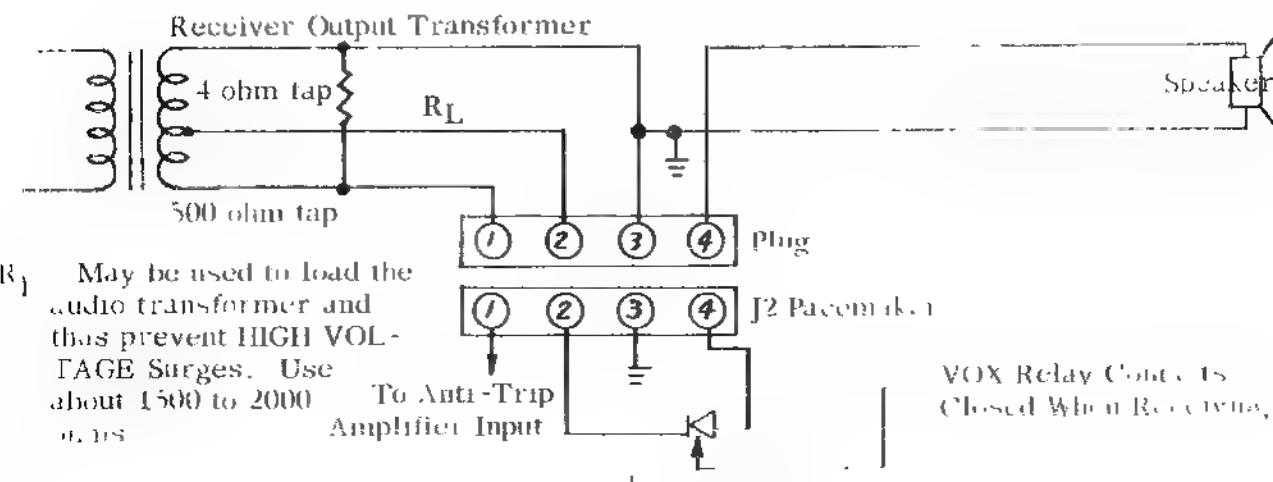
### a Anti-Trip Wiring Procedure

Connect the 500 ohm audio line between pin 1 of J2 and ground which is pin 3. Connect the 4 ohm audio line to pin 2 of J2 and the speaker from pin 4 of J2 to ground. To adjust the anti-trip circuit, the transmitter should be in the VOX PTT position with the VOX gain adjusted as in paragraph 5a.

Adjust the receiver volume to normal listening level. If the station speaker audio activates the VOX relay, advance the anti-trip control until the condition is eliminated. If a 500 ohm audio tap is not available on the station receiver it may be necessary to purchase a 4 ohm to 500 ohm audio output transformer. The 4 ohm winding should be connected in parallel with the speaker line. The 500 ohm output should be connected to pin 1 of the 4 pin plug. If trouble is experienced refer to page 26 for discussion of common troubles.

### b Receiver Disable or Muting

Terminals 2 and 4 of the receiver control plug, J2, are connected to the normally closed side of a set of single pole, double throw, contacts on the VOX relay. When the VOX relay is actuated, the contacts are opened thus muting the receiver. The most convenient method and one which seems to work the best with the anti-trip circuit is to use this set of contacts to open the speaker line.



### C 8. c. 75A-4 Anti Trip and Receiver Disabling

The Collins 75A-4 lends itself quite well to a slightly different method of receiver disabling. The Anti Trip input is still taken from the 500 ohm audio output tap but the receiver standby terminals are used to disable the receiver. Connect pin 1 of J2 to the 500 ohm tap of the receiver. Connect pin 3 of J2 to ground. Connect pins 2 and 4 of J2 to the receiver standby terminals number 1 and 2 on the rear of the receiver.

### D. VIKING PACEMAKER PI-NETWORK TUNING AND HARMONIC SUPPRESSION

The pi-tuning/coupling network in the Viking Pacemaker is designed to load the final amplifier into antenna resistances of nominally 50 to 500 ohms throughout the frequency range of the transmitter. In addition, it is capable of "tuning out" series antenna reactances up to several hundred ohms to complete a good match to most unbalanced antenna systems. The range of antenna impedances which may be matched by the pi-network at frequencies higher than 7.0 mcs. extends from roughly 25 to 2000 ohms.

When the transmitter is well grounded and properly tuned, the higher harmonic suppression is excellent, generally much better than with other conventional methods of antenna coupling. This should be of interest to amateurs afflicted with TVI or other high frequency interference problems.

#### 1. IMPORTANCE OF GROUNDING

To obtain proper tuning, coupling and harmonic suppression with any transmitter antenna coupling system, the part of the circuit designed to operate at RF ground potential must be at RF ground potential. A "room full of RF" is evidence that a high RF potential exists on something in or near the room. In many cases the source of RF is the transmitter's chassis and power cord. This condition is very undesirable for several reasons. The power cord is very closely coupled to the chassis by the electrostatic shields of the power transformers. Three objectional factors which obviously affect the loading of the transmitter when poor grounds are involved are:

- a. The impedance that the output terminal of the transmitter looks into includes not only the true antenna to ground impedance as presented by the antenna feed line but also the transmitter chassis to ground impedance. This additional impedance in some cases will raise the apparent antenna impedance to such a high value that it cannot be loaded by the pi-network.
- b. Part of the transmitter's power is lost in the ground system due to radiation of the ground lead, power cord or cabinet. This power is quickly dissipated in surrounding objects and contributes nothing to effective radiated power except to distort the antenna's normal field pattern.
- c. It is conventional, in designing a transmitter, to bypass harmonics or any possible sources of stray high frequency currents to the chassis on the assumption the chassis will be kept as near ground potential as possible. When a high impedance is presented to these currents at the chassis they are able to radiate to some extent rather than be passed harmlessly to ground.

#### 2. HOW TO OBTAIN A GOOD GROUND

What may appear to be a good ground at one frequency may prove to be a poor ground at another. A single ground lead may have "standing waves" on it due to its length. While it may seem difficult to obtain a good ground over a wide range of frequencies, it can be done and will be well worth the trouble when increased radiation efficiency, ease of

- antenna loading and reduced TVI and BCI result. There is also reduced danger of damaging microphones, receivers and other associated equipment with excessive RF field.

Avoid using the power line, power line conduit or gas lines for RF grounding. Some suggestions which may help to obtain a good ground are

- a. Water pipes or metal building structural members are usually good sources of earth grounds.
- b. Use heavy conductors (#14 or larger) between the connection at the ground point and the transmitter. Copper ribbon is excellent for this purpose.
- c. The use of several ground leads, each of a different length and selected at random may be helpful in keeping grounding impedance low at the transmitter, even though the transmitter is some distance from a true earth ground. The possibility of obtaining an effective ground at any frequency throughout the transmitter's range is quite good. If at any one frequency, one of the ground leads presents a low impedance at the chassis, the chassis is effectively grounded. By changing the length of one of the ground leads experimentally, a good ground can often be obtained at a frequency which has been troublesome. In bringing several leads to the transmitter, small closed loops near the transmitter or antenna feed line should be avoided. Induction fields will tend to raise the impedance of the ground leads.
- d. In cases where it is impossible to obtain a good earth ground, connecting the transmitter chassis to some system of conductors having a very low effective impedance to ground compared to the antenna impedance may be helpful. Usually this artificial "ground" takes the form of a system of radial wires spread horizontally on the floor, a gridwork of wires, or a large metal sheet on the floor below the transmitter. To be most effective, the minimum area covered by the metal conductors should be roughly equivalent to a square, the length of one side of which approaches a quarter wavelength. This system of "grounding" should be experimented with before committing the location of any permanent installation.
- e. A simple counterpoise made up of a single wire attached to the chassis may be helpful. On 10 meters a length of 6 to 8 feet may be attached and the open end cut off 4 inches at a time until the chassis becomes "cold". The open wire may be allowed to drop along the floor although its open end will be somewhat "hot".
- f. A rough check on the effectiveness of the transmitter ground may be made by touching the chassis while watching the PA plate current and grid current with the transmitter operating into an antenna. A change in current upon touching the chassis is indicative of an ineffective ground. If a neon bulb, held between the fingers, can be ignited by touching it to the chassis, the RF present is excessive and is another indication of an ineffective ground. In cases where the transmitter is feeding a low impedance antenna, the test by touching the chassis is more reliable since 50 to 60 volts is required to ignite the neon lamp.

### 3 LOADING RANDOM ANTENNAS WITH THE PI-NETWORK

With the transmitter chassis well grounded, correctly designed antenna systems having relatively "flat" unbalanced feeder systems, can easily be loaded by following the instructions already given, provided the antenna terminal impedances fall within the range of the pi-network. Feeding a balanced system with a feedline over a quarter of one wavelength long, may prove to be surprisingly successful if the transmitter chassis is held at ground potential. The transmission line between the transmitter and antenna will tend to assume a partial balance at the antenna. Some standing waves will result but may not be excessive. The Johnson Matchbox, a universal all band, bandswitched antenna coupler will permit loading of the Viking Pacemaker transmitter to any practical antenna system. In addition, it provides for the use of the Johnson 250-20 Low Pass Filter for increased harmonic suppression.

D. 3      Antennas having random lengths, random feed points and various types of feed lines will exhibit widely different resistance and reactance characteristics. It is well to remember that the feedline is a very important part of the system. A common example of the random antenna is a horizontal wire fed by a single wire feed line. The feed line in this case actually becomes part of the radiating system. An antenna of this type can, in most instances, be fed by the pi-network directly but there are critical dimensions where the antenna series reactance (inductive or capacitive) becomes too high and the antenna resistance can become either too high or too low to be matched by the pi-network.

Antennas with high terminal resistance or reactance can usually be recognized while loading the final stage of the Viking Pacemaker. The final amplifier is normally loaded by reducing the output coupling capacitor (C78) in small steps, retuning the amplifier to resonance each time. This results in an increase in PA plate current and is continued until full loading is achieved. If, however, a point is reached where decreasing the output coupling capacitor (C78) does not result in a marked increase in PA plate current and the PA is not fully loaded, the antenna can be assumed to have a high resistance or reactance at this frequency.

Antennas with low terminal impedance (resistance and reactance both low) can usually be recognized by a noticeable lack of coupling condenser effect in the range of settings normally used at the operating frequency. There will be little or no detuning evidenced as the coupling control is changed.

Several things can be tried in an effort to bring the antenna systems into the tuning range of the pi-network:

- a. Change the length of the feeder line between the antenna and transmitter experimentally 1/8 to 1/4 wavelength.
- b. Change the point of connection of the feedline to the antenna 1/8 to 1/4 wavelength.
- c. Change the antenna length 1/8 to 1/4 wavelength. Antennas shorter than 1/8 wavelength (antenna and feeder) may be difficult to load. They present a high capacitive reactance to the transmitter output terminals. Effective antenna lengths in the vicinity of 1/2 wavelength will in general exhibit characteristics of high resistance, high reactance (inductive or capacitive) or both.
- d. "Load" the antenna feeder by placing an inductor or capacitor in series to cancel out the reactance of the antenna feeder. This may require considerable cut and try and will affect only the reactive component of the antenna impedance. However, it can prove useful in some cases.
- e. L type matching networks of inductance and capacitance may be used to aid impedance matching. Much discussion of this more elaborate method of bringing the antenna impedance within the range of the pi-network could be included, however, the few cases where it is necessary do not justify inclusion herein. Textbook and handbook discussions will be helpful if work along this line is pursued. There is danger of resonating the coupling condenser of the pi-network when using an external coil. This should be watched as excessive voltage built up across the coupling condensers can cause damage. Improper coupling or loading will take place under these conditions.

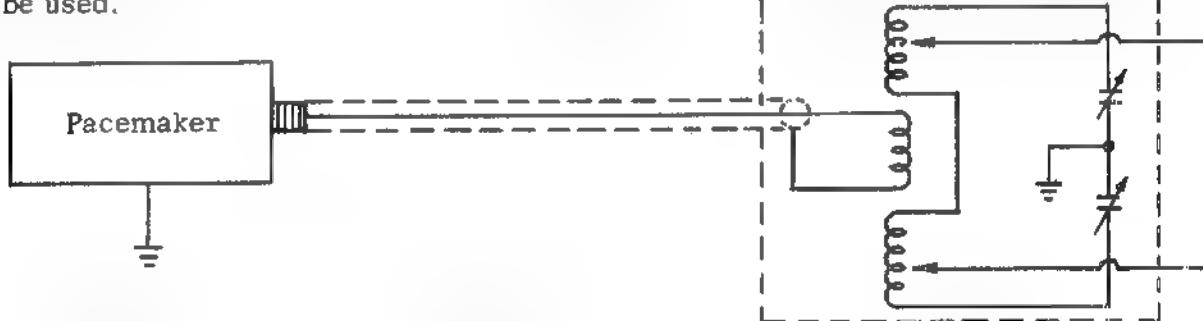
#### 4. DANGERS TO BE AVOIDED AND HINTS WHICH MAY FURTHER AID IN HARMONIC AND TVI REDUCTION

- a. When loading high impedance antennas there is a temptation to "squeeze" the last watt into the antenna by opening the coupling condensers as much as possible. Harmonic suppression is dependent, to a great extent, on the amount of coupling capacity in the circuit. It is wise to use as much coupling capacity as practical at all times. The proper amount of coupling when the antenna impedance is high, can be conveniently determined by holding a neon lamp against the antenna feeder. The coupling condenser can then be opened until little increase in glow is noticed when the coupling condenser

- D 4 a and tuning controls are adjusted for maximum output. A decrease in coupling capacitance beyond this point may cause a higher plate current reading due to reduced plate circuit efficiency. Higher harmonic output will also result as the coupling capacity is reduced beyond the point where the output has leveled off. The random antenna system may present a more favorable impedance to harmonic output than the output on the fundamental frequency; hence it is well to use as much coupling capacity as is practical. It is well to remember that the amount of coupling capacitance needed is dependent on the operating frequency. For example, 2,000 micro microfarads at 3.5 mcs. corresponds to 160 micro microfarads at 28.0 mcs. These are the values necessary to couple resistive loads of approximately 50 ohms, at the frequencies stated.
- b. If the power line voltage is low or the high voltage rectifiers have low emission, the loaded plate current may not reach the normal value. This condition should not be confused with the inability of the pi-network to load an antenna system.

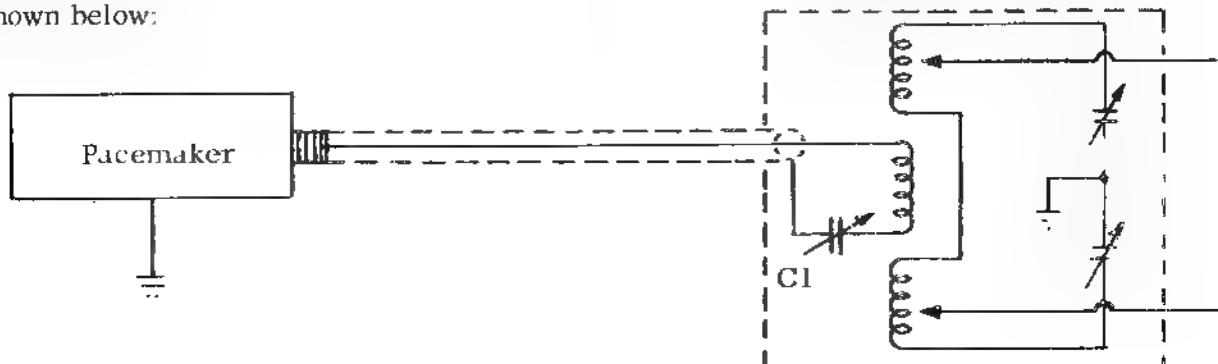
## 5. COUPLING TO BALANCED ANTENNAS

Balanced antennas such as center fed "Zepps", beams and folded dipoles normally use a two wire transmission line and should have equal voltages, 180 degrees out of phase, applied to each feedline terminal. Since the output of the Viking Pacemaker is single ended, unbalanced, a coupler is required for balanced antenna systems. The Johnson Matchbox, a universal all band, bandswitched antenna coupler will permit loading of the Viking Pacemaker to any practical antenna system. In addition, it provides for the use of the Johnson 250-20 Low Pass Filter for increased harmonic suppression. A simple coupler for this purpose is shown below. The tank circuit is resonant at the operating frequency and can be excited by a coaxial line and coupling link. Line impedance is not critical although 52 ohm line will be most desirable if a JOHNSON Low Pass Filter is to be used.



Feedpoint impedance of the coupler is adjusted by means of the inductor taps. Tap adjustment is unnecessary with the Johnson Matchbox. Final amplifier loading is adjusted with the transmitter output coupling controls.

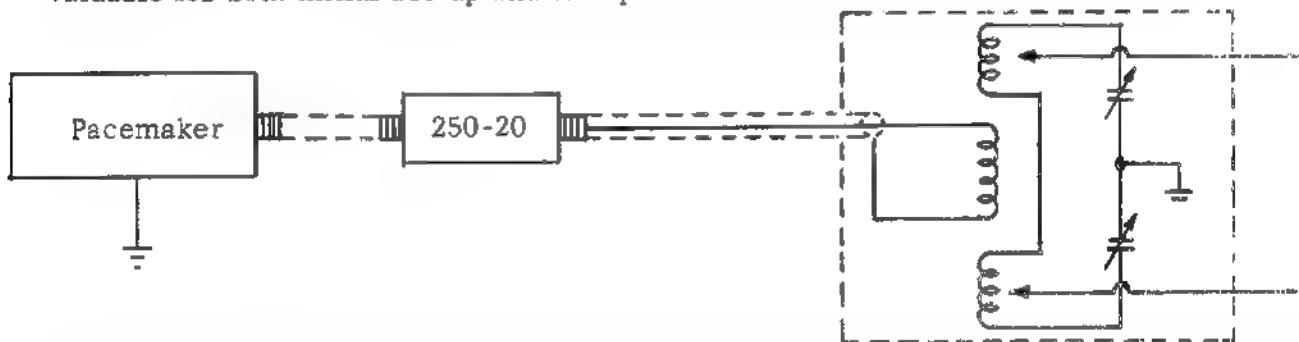
Tuning of the coupler can be made quite broad by making the L/C ratio as high as possible (low "Q") while still permitting the desired loading. Inductive reactance of the coupling link may make it impossible to reduce the SWR of the coaxial line to or below 1 1/2 to 1. If so, the link circuit may be made series resonant by adding capacitor C1 as shown below:



The above problem is non-existent with the Matchbox

## D. 6 USE OF LOW PASS FILTERS

Depending upon how it is tuned, 2nd harmonic attenuation of the Viking Pacemaker amplifier can be as high as 30 db. Since this will permit operation in many locations without television interference, the Johnson 250-20 Low Pass Filter is not an integral component of the Viking Pacemaker but is available as an optional accessory. This filter will provide an additional 75db or more harmonic attenuation with insertion loss less than .25 db. Characteristic impedance is 52 ohms, power rating 1 KW. The low pass filter may be inserted in the coaxial line between the transmitter and the antenna coupler. Coaxial connectors are used at the transmitter and at both ends of the low pass filter to preserve the shielding provided by the coaxial line. It is preferable that the standing wave ratio on the coaxial line be maintained at 2 to 1 or less, therefore the impedance of the line between the Viking Pacemaker and the coupling link should be the same as the characteristic impedance of the filter. (The Johnson 250-20 Low Pass Filter and Johnson Matchbox are 52 ohm impedance.) The section of coaxial line between the transmitter and the low pass filter should be as short as possible and electrical quarter waves should be avoided. An RF bridge such as the Johnson 250-25 for measuring SWR will prove invaluable for both initial set-up and for operational checks.



An end fed half wave antenna may present loading problems both from the standpoint that its impedance is higher than can be matched by the pi-network amplifier of the Viking Pacemaker, or that the low output coupling capacitance used reduces inherent harmonic attenuation below tolerable values. Therefore, the use of a half wave antenna may create TVI problems, while other antennas prove perfectly satisfactory. In these cases it is recommended that the Johnson Matchbox be used.

## E. PACEMAKER ALIGNMENT PROCEDURES

1. The following procedures present the method and sequence of alignment to be employed when adjusting the Viking Pacemaker transmitter. Factory wired transmitters are aligned and tested prior to shipment and should require no adjustment. However, if it is felt that slight adjustments are required, follow the instructions below to obtain optimum performance from your Viking Pacemaker.

### 2. VFO CALIBRATION

The Pacemaker VFO employs two tank circuits. One operates from 3000 KC to 3500 KC on the bands 80 through 15 meters and the other from 3000 KC to 4700 KC on the 10 meter band.

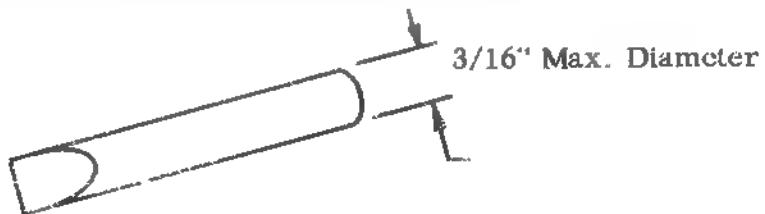
#### a. Set Up Instructions

- (1) Use a signal generator, receiver, or frequency standard of known accuracy which can tune to 3000 KC, 3500 KC and 4500 KC. It should be remembered that the VFO calibration will be only as good as the standard used to calibrate it.
- (2) Warm up the signal generator, receiver or frequency standard for at least one-half hour or as long as recommended in the instruments instructions.

- a (3) Set up a receiver capable of detecting each of the frequencies listed in a (1) above. Attach a lead to the receiver antenna input and wrap several turns of this antenna lead around the 6BE6 mixer tube, V6 (Remove the tube shield). Allow the receiver to warm up one-half hour to stabilize the local oscillator and log dial settings for 3000 KC, 3500 KC and 4700 KC. The beat frequency oscillator in the receiver may be used to log and compare the signal generator and VFO frequencies but it is desirable to obtain the final zero beat indications between the VFO and signal generator signals without the beat frequency oscillator. Avoid setting the receiver on, or logging image frequencies.
- (4) Warm up the Viking Pacemaker in the ZERO position for 1/2 hour. Remove the 6AU6 Crystal Oscillator tube, VI2.
- (5) To obtain proper calibration, the dial pointer should be horizontal when the VFO capacitor is fully meshed. This may be checked without removing the VFO cover by rotating the VFO knob until the pointer indicates about 3.55 mc. Locate the signal on a receiver with the BFO on (it should be near 3.055 mc). Zero beat the tone with the VFO knob. Now, tune the receiver slightly lower in frequency. Again zero beat with the VFO. Continue this process of lowering the receiver frequency and then zero beating with the VFO until it is impossible to zero beat the note. At this point, as one rotates the VFO knob, the beat note will fall in frequency, and then rise without reaching zero-beat. This point of the lowest frequency beat note is the full mesh condition of the VFO capacitors. The dial pointer should be horizontal. If it is not, remove the dial escutcheon and, without moving the shaft loosen the dial pointer setscrew and set the pointer horizontal. Tighten the setscrew.

b Low Band Calibration

- (1) Set the BANDSWITCH on 80 meters and the VFO dial to 4000 KC. Set the signal generator to 3500 KC and the receiver to 3500 KC. Adjust the low band capacitor, LO "C", to obtain a zero beat between the VFO and the signal generator (Refer to Figure 2).
- (2) Turn the VFO dial to 3500 KC, the signal generator to 3000 KC and the receiver to 3000 KC. Adjust the slug of low band series inductor LO "L", to obtain a zero beat between the VFO and the signal generator. Use a sharpened plastic or phenolic rod for this adjustment. See sketch below.



- (3) Repeat the adjustments of steps 1 and 2, above, until the VFO is calibrated as closely as the ability to reset the two units warrants.

c High Band Calibration

- (1) Set the BANDSWITCH to 10 meters and the VFO dial to 29.5 mc. Set the signal generator to 4500 KC, and the receiver to 4500 KC. Adjust the high band capacitor, HI "C", to obtain a zero beat between the VFO and the signal generator.
- (2) Set the VFO dial to 28.0 mc. Set the signal generator and receiver to 3000 KC. Adjust the slug of the high band inductor, HI "L", to obtain a zero beat between the VFO and the signal generator.

E. 2 . (3) Repeat steps 1 and 2, above zero beating the signal generator and VFO as accurately as the ability to reset the two units warrants

d Replace the 6AU6 crystal oscillator tube, V12

### 3. CRYSTAL OSCILLATOR ADJUSTMENT

- a. The crystal oscillator circuits are adjusted by means of the five tuning slugs on the left front side of the crystal oscillator chassis. See Figure 4B.
- b. Attach a vacuum tube voltmeter RF probe to the junction of C133 and C152.
- c. Rotate the BANDSWITCH to 80 meters Turn the equipment to the STANDBY position.
- d. Adjust the 500 KC tank circuit inductor "80 Xtal" to obtain a peak reading on the vacuum tube voltmeter. If this reading is greater than 1 1/2 volts adjust the slug to obtain 1 1/2 volts.
- e. Repeat the above procedure on the 40, 20, 15 and 10 meter bands The crystal frequencies involved are 4 mc., 11 mc., 18 mc., and 25 mc and the controls are 40 Xtal, 20 Xtal, 15 Xtal and 10 Xtal respectively See Figure 4B for location of adjusting slugs. Always tune for a peak VTVM reading or 1 1/2 volts whichever is smaller
- f. Remove the vacuum tube voltmeter RF probe.

### 4. RF EXCITER TUNED CIRCUIT TRACKING

- a. Once the VFO and crystal oscillator have been aligned as in paragraphs 2 and 3 above, the RF exciter section may be aligned
- b. Couple a lead from the receiver to the 6CL6 plate compartment. Remove the 5R4GY High Voltage rectifier tube, V16, and the two OB2 regulator tubes, V19 and V20 Turn the transmitter OPERATE switch to MAN-CW. Rotate the MODE switch to AM-LO and advance the CARRIER INSERT knob to 5. Rotate each of the 15 variable ceramic trimmer capacitors, to their mid-scale position; that is, with the slot of the capacitor running from front to back on the chassis. Rotate METER switch to GRID. Refer to Figure 2 for location of adjusting components.
- c. 80 Meter Tracking
  - (1) Rotate BANDSWITCH to 80 M. Set the EXCITER tuning dial to "10" and the VFO dial to 3500 KC. Tune the receiver to the Pacemaker output signal of 3500 KC. Be careful not to tune to the VFO frequency which is at 3000 KC
  - (2) Adjust the three 80 meter inductor slugs "80 L" for a peak reading on the S meter
  - (3) Rotate the VFO dial to 4000 KC Set the EXCITER tuning to "90" Tune the receiver to the Pacemaker output frequency of 4000 KC. Adjust the three variable trimmer capacitors "80 C" for a peak S meter reading. At this point grid current should be indicated It may be necessary to advance the CARRIER INSERT control to obtain grid current.
  - (4) Repeat steps 2 and 3, above, tuning for maximum grid current The receiver will no longer be required. If the slug or capacitor tuning seems broad retard the CARRIER INSERT control to drop off the grid current slightly until the peaks are sharper When the grid current appears to peak in the "90" position at 4 mc within ten dial divisions, the circuits are tracked

E 4 d 40 Meter Tracking

- (1) Rotate BANDSWITCH to 40 M position. Rotate VFO dial to 7.0 mc., and the EXCITER tuning dial to "10". Tune the receiver to the Pacemaker signal at 7.0 mc.
- (2) Adjust the three 40 meter inductor slugs "40 L" for a peak reading on the S meter.
- (3) Rotate the VFO dial to 7.3 mc., and the EXCITER tuning to "90". Tune the receiver to the Pacemaker output signal at 7.3 mc. Adjust the three 40 M variable capacitors "40 C" for a peak S meter reading.
- (4) Repeat steps 2 and 3 above, tuning for maximum grid current until a peak reading is obtained at 7.3 mc. when the EXCITER dial is tuned through "90" and a "10" when the VFO dial is set at 7.0 mc. These peaks should occur within ten dial divisions of 10 and 90.

e. 20 Meter Tracking

- (1) Rotate the BANDSWITCH to 20 M. Rotate the VFO to 14.0 mc. Tune in the Pacemaker signal at 14 mc. on the receiver. Set the EXCITER tuning dial to "10".
- (2) Adjust the three 20 meter inductor slugs "20 L" for a peak reading on the S meter.
- (3) Rotate the VFO dial to 14.300 mc., the EXCITER tuning to "90". Tune in the signal at 14.3 mc. on the receiver. Adjust the three 20M variable trimmer capacitors "20 C" for a peak reading on the S meter. Grid current should be indicated.
- (4) Repeat steps 2 and 3 until the grid current peaks at the "90" position at 14.3 mc. and at the "10" position at 14 mc., or within ten dial divisions of "10" or "90".

f. 15 Meter Tracking

- (1) Rotate the BANDSWITCH to the 15 meter position. Rotate the VFO dial to 21.0 mc., and tune in the signal on the receiver at 21 mc. Set the EXCITER tuning dial to "10". Adjust the three 15 meter variable inductor slugs "15 L" for a peak S meter reading.
- (2) Rotate the VFO dial to 21.45 mc. and the EXCITER tuning dial to "90". Adjust the three 15 meter variable capacitors "15 C" for a peak S meter reading. Grid current should be indicated.
- (3) Repeat steps 1 and 2 above until the grid current peaks at the "90" position at 21.45 mc. and at the "10" position at 21 mc., or within ten dial divisions of "10" and "90".

g. 10 Meter Tracking

- (1) Rotate the BANDSWITCH to the 10 meter position, the VFO dial to 28.0 mc., and the EXCITER tuning to "10". Tune the receiver to the Pacemaker output frequency of 28 mc. Adjust the three 10 meter variable inductor slugs "10 L" for a peak reading on the S meter.
- (2) Rotate the VFO dial to 29.7 mc. and the exciter tuning to "90". Tune the receiver to the Pacemaker output frequency of 29.7 mc. Tune the three 10 meter variable capacitors "10 C" for a peak S meter reading. Grid current should be indicated.

E. 4 g. (3) Repeat steps 1 and 2 above until the grid current peaks within ten dial divisions of "90" at 29.7 mc and within ten dial divisions of "10" at 28.0 mc

- b. This completes the exciter tracking. A minimum of .4 ma of grid current should be available on each band.

## 5. AUDIO BALANCE AND PHASE SHIFT ADJUSTMENTS

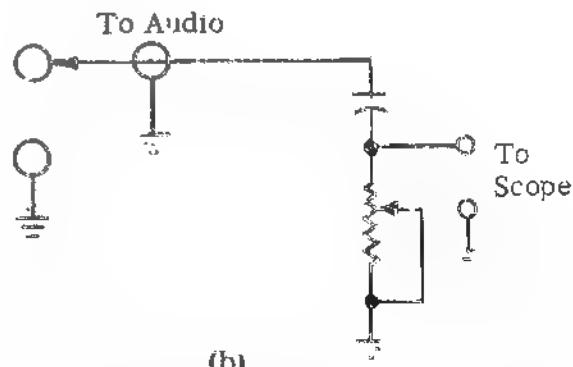
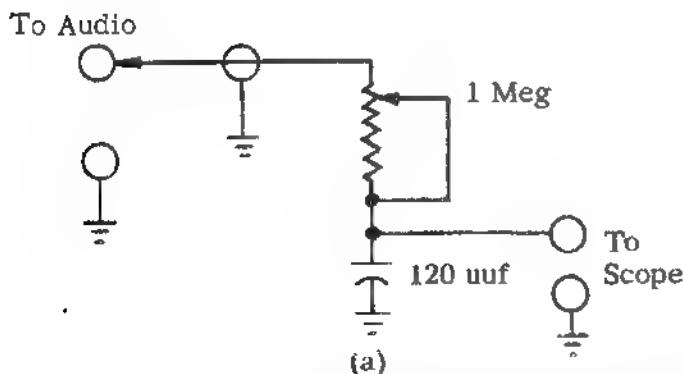
- a. It is necessary to obtain  $90^\circ$  phase shift from the phase shift network and to adjust for equal gain between the two halves of the phase inverter tube, V3
- b. Set the Pacemaker OPERATE switch to STANDBY. Set the MODE switch to SBI. Connect an audio signal generator capable of .005 volts of output at 2000 cycles to the microphone input. Connect a shielded lead to the junction of L3 and C20 in the balanced modulator section. Ground the shield. Connect the other end of the shielded lead to the horizontal amplifier input of an oscilloscope

Connect a similar lead to the vertical amplifier input of the scope. Do not connect to the Pacemaker as yet. Set the scope horizontal frequency to "X input" or its equivalent. Set the horizontal gain to maximum. (Set R-18, the AUDIO BALANCE Control to the middle of its range.)

- c. Set the audio oscillator to 2000 cycles and advance the AUDIO gain control until a deflection of about 1 inch or so is obtained on the scope. Measure this deflection using the grid on the scope face, or some other means. Turn the horizontal gain to zero, and connect the lead from the vertical amplifier to the same point in the Pacemaker as the horizontal lead, i.e. the junction of L3 and C20. Adjust the vertical gain to obtain the same deflection as measured above

### NOTE

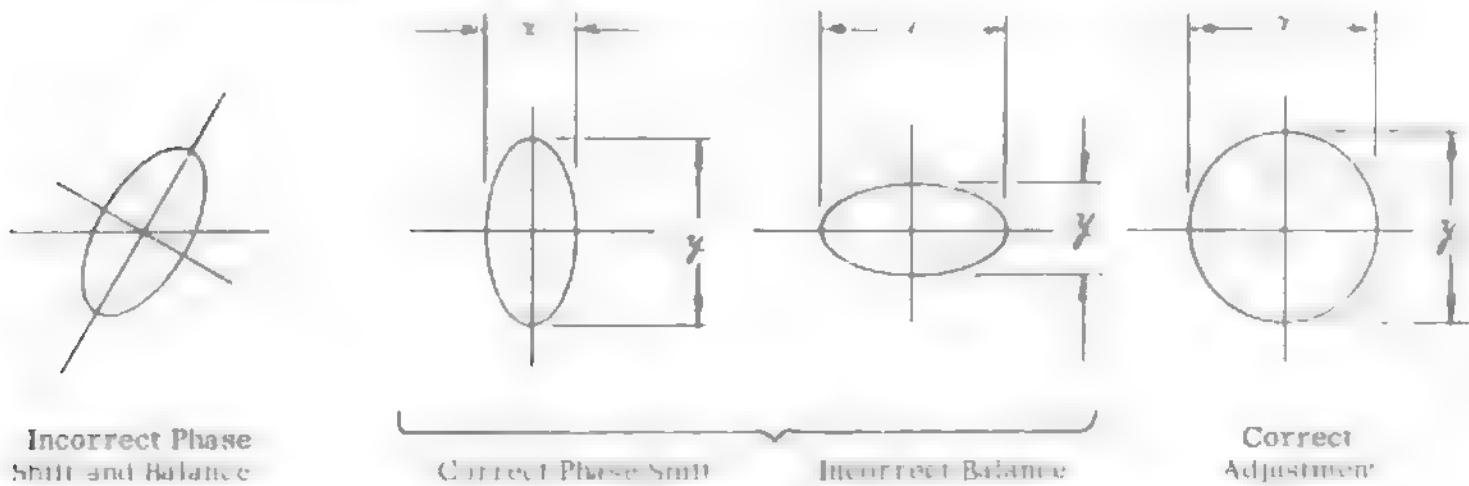
The oscilloscope must not contribute any phase shift. The phase shift of the oscilloscope may be checked at this point by increasing the horizontal gain to maximum again. The scope presentation should be a straight line oriented at a  $45^\circ$  angle. If there appears to be an ellipse or two lines, the scope has phase shift. A correcting network composed of a 1 megohm potentiometer and a 120 uuf capacitor should be used to correct for the scope phase shift. The resistor and capacitor should be connected as shown below:



The figure to be used will have to be determined experimentally. If figure (a) does not correct the phase shift but makes it worse, use the connection shown in figure (b). Adjust the potentiometer to obtain a straight line at  $45^\circ$  on the oscilloscope. Do not disturb this setting. Proceed now with paragraph (d) below

- d. Remove the vertical amplifier leads from L3 and C20 and connect to the junction of L5 and C151. Advance the horizontal gain to maximum again. A figure which resembles a circle or ellipse should be evident on the scope face

Adjust R11, the phase shifter, to obtain a minimum 90° phase shift + evidence of a light ellipse shape. Note: A 90° phase shift is obtained when the ellipse or ellipse has its axis at 90°. See sketch below:



Adjust R18, the AUDIO BALANCE Control, to obtain a nearly perfect circle. i.e. the X and Y dimensions should be equal in length. Readjust the two controls as required to obtain a perfect circle. Rotate the MODE switch back and forth between SBI and SB2. The figure should not change shape appreciably.

- d This completes the adjustment of the Audio Balance and Phase Shift controls. Remove the oscilloscope leads

## b RF PHASE SHIFT ADJUSTMENTS

1. RF phase shift network adjusts for optimum unwanted sideband suppression. Before proceeding with this adjustment the Audio Balance and Audio Phase Shift should be adjusted per paragraph 5, above.

- (1) Set OPERATE switch to ZERO position. Set MODE switch to SBI position. Apply a 2000 cycle sine to the microphone input. This should be no greater than .01 volts. Set the BAND SELECT control to 15 meters and the VFO dial to 21 m. Set the AUDIO gain to 0. Couple the receiver to the GCL6 plate compartment.
- (2) Tune the receiver to the Pacemaker carrier at 21 mc. Set the receiver at its narrowest selectivity position. This position should provide selectivity equal or better than the sharpest position of a good Crystal filter. Tune the BAL MOD control for a peak reading on the S meter. Adjust the BALANCE controls for minimum S meter reading. This balances out the carrier.
- (3) Advance the AUDIO gain control to approximately 15. Very carefully tune the receiver slightly higher in frequency until the S meter peaks. This is the desired sideband. Rotate the MODE switch to SB2. The S meter should drop. Adjust the CHANNEL GAIN control R33 for minimum S meter reading. Adjust the 15 meter RF phase shift variable inductor stage to R6 for a further reduction in S meter reading. Continue to adjust the two controls alternately until the maximum S meter reading is obtained.
- (4) This completes the adjustment of the CHANNEL GAIN control and the 15 meter RF phase shift network. Continue with the same set up to element 40, 20 and 10 meter RF phase shift networks as given below. Do not change setting of CHANNEL GAIN R33 from that obtained above.

E 6 b 10 Meter RF Phase Shift Adjustment

- (1) Rotate BANDSWITCH to 10 meter. AUDIO gain to "0". VFO to 28.0 mc EXCITER tuning to "10". Tune to Pacemaker output signal at 28.0 mc with receiver. Use narrowest selectivity setting on receiver MODE switch on SB1
  - (2) Tune the BAL MOD control for a peak reading on the receiver S meter. Adjust CARRIER BALANCE controls for minimum S meter reading. Advance AUDIO gain control to about "5". Very carefully tune receiver slightly higher in frequency until S meter peaks. This is the desired sideband. Rotate MODE switch to SB2 position. The S meter reading should drop. Adjust the two 10 meter RF phase shift variable inductor slugs "10 RF" for a minimum S meter reading
  - (3) This completes the 10 meter RF phase shift adjustment.
- c. 80, 40 and 20 Meter RF Phase Shift Adjustments
- (1) The adjustments for the 80, 40 and 20 meter RF phase shift networks are identical. Each should be adjusted in turn. The outline below should be followed, using the appropriate band, frequency and variable inductor.
  - (2) Rotate the BANDSWITCH to the desired band 80, 40 or 20. Audio gain to "0", VFO to lower end of band, 3.5, 7, or 14 mc. MODE switch to SB1. Use narrowest selectivity position of receiver and tune to the Pacemaker output at 3.5 mc., 7 mc., or 14 mc.
  - (3) Tune the BAL MOD control for a peak reading on the S meter. Adjust the CARRIER BALANCE controls for minimum S meter reading. Advance the AUDIO gain control to "5". Very carefully tune the receiver higher in frequency until the S meter peaks. This is the desired sideband. Rotate the MODE switch to SB2 position. The S meter reading should drop slightly. Adjust the RF phase shift slugs "80 RF" "40 RF" or "20 RF" for 80, 40 or 20 meters, respectively for a minimum S meter reading. This completes the RF phase shift network adjustment.

## 7. NEUTRALIZATION

The Pacemaker has two neutralized stages which should be adjusted on 15 meters

a. Power Amplifier, 6146, Neutralization

Set-up, tune and load the transmitter on 15 meter CW per section C of this manual. Note the point on the PLATE tuning control at which the plate current dips. Rotate the METER switch to the GRID position and observe the reading of the PLATE tuning control at which the grid current peaks. The grid current peak and the plate current dip should occur at the same position of the PLATE tuning control. If they do not adjust the plate neutralizing capacitor as follows:

- (1) If the grid current peak occurs at a dial reading which is greater than that of plate current dip, the neutralizing capacitance should be increased
- (2) If the grid current peak occurs at a dial reading which is less than that of plate current dip, the neutralizing capacitance should be decreased.

### CAUTION

The stator of the neutralizing capacitor has 750 volts dc applied to it. Use caution when making any adjustments. Adjustment of the capacitor should be made with an insulated screwdriver or alignment tool

b. 6CL6 Neutralization

- (1) Disable the 6CL6 by temporarily disconnecting the red lead on terminal 2 of TS18

- E - b
- (1) CAUTION Remove power plug before attempting to disconnect the lead of terminal 2. To neutralize the 6CL6 stage, turn the MODE switch to AM-LO, CARRIER INSERT to about "5". Set OPERATE switch to ZERO. Set BAND-SWITCH to 15 (NOTE, TS-18 is adjacent to the 6CL6 socket) meters, VFO to 21.45 mc., EXCITER tuning to "90".
  - (2) Prepare a lead consisting of coaxial cable or shielded lead with the insulated lead tied to the ground lead at one end to form a single loop. Connect the free end to the receiver antenna input terminals. Couple the loop very closely to the final grid circuit near the final grid suppressor, E2.
  - (3) Tune the receiver to the Pacemaker output at 21.45 mc. Adjust the 6CL6 neutralizing capacitor C165 for a minimum S meter reading.
  - (4) Reconnect the red lead to terminal 2 of TS18 and solder. This completes neutralization of the Pacemaker.

## 8. BIAS POTENTIOMETER ADJUSTMENT

The Pacemaker Final Amplifier is designed to operate with about 20 ma. of idling plate current when no drive is present. Tubes vary considerably in their characteristics and it may be necessary to adjust the BIAS adjustment R76.

- a. Turn BANDSWITCH to 10 meters.
- b. Turn EXCITER tuning to "90" and VFO to 28.0 mc.
- c. Turn CARRIER INSERT to "0".
- d. Set OPERATE switch to MAN-CW and MODE to SB1.
- e. Adjust CARRIER BALANCE controls for minimum plate current. If the current is low, there may not be any noticeable effect when the controls are adjusted
- f. Adjust the BIAS adjustment, R76, see figures 1 and 2, to obtain 20 ma. of idling current.

## F. GENERAL INFORMATION ON PACEMAKER AND SSB OPERATION

### 1. SB1, SB2, AM-LO AND AM-HI

Some confusion exists as to exactly what the above terms indicate. SB1 is always the upper sideband and SB2 is always the lower sideband on the Pacemaker. Some of this confusion undoubtedly arises from familiarity with other transmitters when the nomenclature may have been different or where in some of the other SSB transmitters the sidebands may change from band to band depending on the injection frequencies. It is also interesting to note that the same problem exists in some receiver set-ups wherein the receiver changes from high to low side oscillator injection when going from band to band. In this case, the sidebands will also change requiring a change in the receiver set-up when receiving, for example, the lower sideband on different amateur bands.

AM-LO and AM-HI have no reference to LO sideband and HI sideband. AM-LO actually refers to single sideband AM, low level AM, so to speak. It is carrier and the lower sideband. AM-HI is used when one desires to run conventional double sideband AM to a high powered class C final amplifier. The Pacemaker does not supply the AM, however, when in the AM-HI position, 60 watts of unmodulated R.F. output is available at any frequency in the amateur bands to be used as excitation for the Class C, AM final. Approximately .5 volts of audio is also available at the rear of the Pacemaker. This audio may be used to drive an intermediate audio amplifier driver such as the Johnson Audio Amplifier, 250-33, which in turn drives the high powered modulators for the final amplifier.

It is possible to tune and load the transmitter on a frequency only to find there is no modulation and that the carrier cannot be balanced out. In actuality, the transmitter is tuned to the VFO frequency instead of the sum of the VFO and the crystal oscillator frequencies. Inherently the frequency scheme of the Pacemaker is mathematically sound; there is only one band where it is possible to tune up on the wrong frequency. This is true on 80 meters where the VFO covers the range 3.0 to 3.5 mc for output frequencies of 3.5 mc to 4.0 mc (VFO + 500 KC from crystal oscillator), respectively. The EXCITER tuning dial is designed to ALWAYS cover the entire amateur band so that the high limit of the bands tunes at about "90" on the EXCITER tuning and the low end of the band tunes at about "10". Thus on 80 meters, with the EXCITER tuning at "10", the exciter stages will pass 3500 KC (low end of 80 meters). This 3500 KC is normally obtained from the mix between the VFO at 3000 KC and the crystal oscillator at 500 KC ( $3000 + 500 = 3500$ ). However, if one wanted to QSY to 4000 KC, he would move his dial to 4000 KC. The VFO is now at 3500 KC. Obviously, if one doesn't change the EXCITER tuning, it is still tuned to 3500 KC and the VFO frequency will be passed and drive the 6146. Proper tuning of the EXCITER tuning will provide proper operation. The important thing to remember is that the EXCITER tuning covers the range from "10" to "90" when tuning from the low to the high frequency limits of any amateur band. ALWAYS be sure that the EXCITER tuning is set at the correct end of the band.

### 3. ANTI-TRIP OPERATION

A large amount of anti-trip trouble can be due to receiver audio action. In many receivers, the STANDBY or TRANSMIT functions merely remove the B+ from the receiver circuits. When the system is returned to the receive position, a loud click is usually evident in the receiver audio. This loud click will sometimes activate the voice operate circuits thus shutting off the receiver. In the absence of audio the transmitter will again stand by, the click will reoccur and begin a continuous popping off and on of the system. The same results sometimes occur in receivers which use other methods of deactivating the receiver circuits.

### 4. POWER DIVIDER

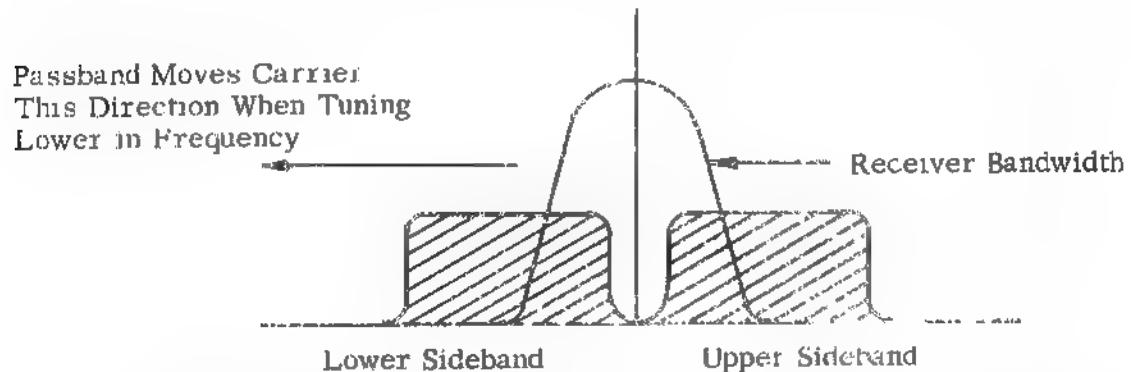
There has been some question regarding the use of a Power Divider with the Pacemaker in conjunction with high power linear amplifiers such as the Viking Kilowatt. The questions range from when is it required to why is it required. The power divider is required whenever the Pacemaker's rated output is greater than that required for driving the high power linear to its rated input. It is important that the Pacemaker (or any other exciter driving a linear amp) always be run at its full input on single sideband and AM LO. That is, the audio gain must be set to just draw grid current on modulation peaks. The reason for this is that when the Pacemaker is operating properly, one might expect to find 60 watts of output and of this 60 watts, .006 watts would be carrier. Now, if the high power linear only requires 3 watts of drive and the audio gain is adjusted to provide only 3 watts of output, the .006 watts of carrier is a much larger percentage of the 3 watts than it was of the 60 watts. This same percentage or ratio of carrier to total input will also appear in the linear amplifier. The ratios incidentally are 10,000 to 1 or 40 db in the first case and 500 to 1 or 22 db. in the second case. However, if a power divider is used, the 60 watts is divided down to 3 watts by a factor of 20. The .006 watts is also divided by 20 so that the input will be 3 watts total, with .0003 watts on this being carrier. This is still 10,000 to 1 and the system will still retain its 40 db of carrier suppression. So always operate the Pacemaker on single sideband and AM-LO at its full capabilities and use swamping or dividing action to dissipate the excess power when using the Pacemaker as a driver for a high power linear amplifier.

## CARRIER AND SIDEBAND SUPPRESSION

There is much misunderstanding among SSB beginners and also oldtimers who feel that there is no carrier on SSB. This, of course, is not true. Someone might comment "I can read S9 on my receiver when the carrier is supposedly balanced out." Actually there are cases where one might read even higher than S9. However, the ratio of carrier present in the "balanced out" condition to carrier present when fully loaded to 2 ma of grid current and 115 ma of plate current should still remain about 40 db or better. In other words, if the Pacemaker is providing a signal in the CW position, for instance which reads 40 db over S9, the Pacemaker will still read about S9 with the carrier balanced out. This is true of any SSB transmitter - the carrier will be down approximately 40 db from the desired sideband and may be quite strong when the received signal is very strong and is particularly evident when local checks are being made. The same holds true for unwanted sideband suppression which should be about 30 db or better on all bands, with both sidebands being equal in suppression. If the station receiver is indicating signals equivalent to 40 db over S9 when listening on the desired sideband, the other sideband might register as high as 10 db over S9. However, the unit is still working properly and if contact is made with another station (and the other operator is familiar with proper sideband tuning procedures), the Pacemaker will have an outstanding signal.

### 6. RECEIVER TUNING

In many instances amateurs do not know how to tune their receivers so as to hear only one of the sidebands. This is not to be confused with tuning in an SSB signal. On most modern receivers with sharp selectivity, if one tunes the receiver for a maximum signal, the receiver will pass the carrier and the low frequency components of the sidebands as in the sketch below:



If one leaves the receiver main tuning as is, and adjusts his BFO to tune in a single sideband station, the relation of the sideband to the passband will remain the same. That is to say the receiver would not be able to discriminate between the sidebands and would be unable to tell if the transmitter was on upper or lower sideband since the receiver would pass the lower frequencies of each sideband equally well. To tune the receiver so as to receive only one sideband proceed as follows: Tune the receiver main tuning dial for maximum received signal. If it is desired to listen to only the lower sideband, tune the main tuning lower in frequency until a noticeable drop in signal occurs. This in effect puts the passband of the receiver lower in frequency. Now adjust the BFO to obtain proper SSB reception. To receive the upper sideband tune the main tuning upward in frequency and reset the BFO. Note the settings of the BFO knob for lower and upper sideband reception and in the future use pre set the BFO knob for the desired sideband and tune only the main tuning. If one has a selective enough receiving system, be it only a receiver or a combination of receiver and auxiliary equipment, the foregoing procedure should enable one to distinguish between sidebands and even measure sideband suppression.

There are many articles in the periodicals and handbooks which deal with SSB reception. It is strongly recommended that these be studied before one tries to determine sideband suppression with a receiver.

## TYPICAL OPERATING DATA AND TROUBLE SHOOTING

### 1 TROUBLE SHOOTING

- a Schematics, photographs and charts aid greatly in trouble shooting and are furnished in this section for reference. Particularly useful are the typical operating voltages, current readings and resistance measurements. Use these charts and listings to save time in locating trouble.
- b Some precautions to be observed are.
  - (1) Be careful while making High Voltage Measurements DO NOT TAKE CHANCES
  - (2) Never depend on bleeder resistors to discharge capacitors. When turning equipment off, discharge each filter condenser with a screwdriver which has a well insulated handle.
  - (3) All power supplies must be off and discharged when making ohmmeter measurements with the ohmmeter.
- c It is nearly impossible to anticipate all troubles, operating errors, or component failures in an equipment such as the Pacemaker. The best procedure to follow is to attempt to isolate the trouble to one of the main sections of the equipment such as
  - (1) High Voltage Supply
  - (2) Low Voltage Supply
  - (3) Bias Voltage Supply
  - (4) Audio Circuits
  - (5) Balanced Modulator Circuits
  - (6) VFO Circuits
  - (7) Crystal Oscillator and RF phase shift circuits
  - (8) RF exciter circuits
  - (9) Final Amplifier Circuits
  - (10) Control Circuits
  - (11) Auxiliary Circuits such as VOX, Anti-Trip, etc

A thorough understanding of the Pacemaker block diagram and Theory Operation will prove an invaluable aid in localizing any trouble. Once the trouble is localized the primary offenders would be the tubes. They should be checked or a good tube substituted in the equipment. Frequent reference to the voltage and resistance charts will also aid toward a swift and accurate analysis of the trouble.

### 2 TYPICAL OPERATING DATA

Figures F1 and F2 are tables showing typical operating voltages and typical resistance readings. Table F3 indicates transformer and choke winding resistances.

Table F4 indicates typical dial settings when operating the Pacemaker into a 52 ohm non-inductive load.

TUBE	PIN								
	1	2	3	4	5	6	7	8	9
V1-12AX7	102	0	0	0	0	162	0	1.57	6VAC
V2-12AU7	27.5	0	12.5	0	0	47	0	0.5	6VAC
V3-12AT7	19.5	-0.1	2.9	0	0	195	0	4.1	6VAC
V4-ECC-81	330	-6	0	0	0	320	7	0	6VAC
V5-ECC-81	330	-6	0	0	0	320	-7	0	6VAC
V6-6BE6	-2.65	2.45	0	6 VAC	290	122	0	---	---
V7-6AU6	-1.5	0	0	6 VAC	278	218	0	---	---
V8-6CL6	6.4	0	212	0	6 VAC	320	0	212	0
V9-6146	0	6VAC	215	0	-78 *	0	0	0	6VAC
V10-12AT7	123	0	2.4	0	0	+192	-6.7 /	11.7 /	6VAC
V11-6AL5	.4	37 Sig. AC	0	6 VAC	58.5AC	0	---	---	---
V12-6AU6	-6.9	0	0	5.3 VAC	315	150	0.95	---	---
V13-12BH7	330 Tie Point					330	0	12.5	5.3 AC
V14-6AU6	-6.4	0	0	5.9	310	150	.08	---	---
V15-OA2	150	0	0	0	150	0	0	---	---
V16-5R4GY	760	5VAC #	900 AC		900 AC		780 (5VAC #)		
V17-5U4G	320	5VAC #	410 AC		410 AC		350 (5VAC #)		
V18-6X4	-180	-180	6VAC	0	255 AC	---	255 AC	---	
V19-OB2	110	---	---	---	110		0		
V20-OB2	210	110	---	---	210	---	110		
V21-OA2	0	-150	---	---	---	-160	-150		

Measurements made with 20,000 ohms/volt Multimeter  
 Pacemaker loaded to 120 ma and .2 ma of GRID CURRENT  
 6146 Plate Voltage - 750 Volts

\* with 0.2 ma Ig  
 / Audio Input .005 Volts at 2,000 cps.

# Measured between pins 2 and 8 of Respective sockets  
 Readings may vary  $\pm$  20% due to component tolerances

TABLE F1  
 PACEMAKER VOLTAGE MEASUREMENTS

TUBE	PIN								
	1	2	3	4	5	6	7	8	9
V1 12AX7	220K	1 Meg	470	0	0	275K	500K	3.6K	0.3
V2 12AU7	30K	1 Meg *	3 SK	0	0	270K	1 Meg	4.5K	0.3
V3 12AT7	40K	1 Meg	4.7K	0	0	40K	1 Meg	4.5K	0.3
V4-ECC-81	22K	920K	0	0	0	25K	1.1 Meg	0	0.3
V5-ECC 81	22K	1.1 Meg	0	0	0	22K	1.1 Meg	0	0.3
V6-6BE6	25K	680	0	0.3	27K	17.5K	10K	---	---
V7-6AU6	300K	0	0	0.3	28K	50K	0	0	0
V8-6CL6	250	110K	40K	0	0.3	20K	0	40K	110K
V9-6146	0	0.3	25K	0	150K	0	0	0	0
V10 12AT7	270K	920K	3.2K	0	0	32K	Inf.	450	0.3
V11-6AL5	110K	110K	0	0.3	Inf.	Inf.	Inf.	---	---
V12-6AU6	100K	0	0	0.5	25K	150K	150	---	---
V13-12BH7	Tie Point 20K	---	---	0	0	20K	100K	870	0.3
V14-6AU6	100K	0	0	0	20K	40K /	6.4	---	---
V15-OA2	40K	40K	---	110	---	115	---	0	0
V16-5R4GY	40K	40K	---	25	---	25	---	40K	40K
V17-5U4	20K	20K	---	0	0	Inf	13	---	20K
V18-6X4	40K	40K	---	---	---	Inf	0	0	---
V19-OB2	25K	Inf.	---	---	25K	---	---	---	---
V20-OB2	0	32K	---	---	---	33K	32K	---	---

Measurements made with 20,000 ohms/Volt Ohm-Milliammeter  
Unit OFF

\* AUDIO GAIN on "10"  
/ OA2 in socket

Readings may vary + 20% due to component tolerance

TABLE F2  
TUBE MEASURED RESISTANCE AND ASSEMBLIES

ITEM	LEADS	RESISTANCE (OHMS)
T1 Audio Transformer	Green to Black	17
	Blue to Red	310
T2-Power Transformer	Red to Red	240
	Blue to Blue	45
	White to White	28
	Green to Green	.01
	Yellow to Yellow	.01
	Brown to Brown	.02
	Black to Black	.4
L31-High Voltage Choke	Black to Black	135
L32-Low Voltage Choke	Black to Black	180

Readings taken with 20,000 ohms/volt Volt-Ohm-Milliammeter.

Readings may vary  $\pm$  20% due to component tolerances.

TABLE F3  
TRANSFORMER AND CHOKE WINDING RESISTANCES

FREQ. (MC)	TUNING		LOADING	
	EXCITER	FINAL	AUX.	FINE
3.5	10	58	4	0
4.0	92	84	4	30
7.0	8	60	5	80
7.3	88	64	6	30
14.0	10	74	6	40
14.3	85	76	6	45
21.0	11	69	7	20
21.45	88	71	7	22
28.0	10	76	7	40
29.7	88	79	7	42

Unit loaded to 115 ma plate current and .2 ma grid current into 52 ohm non-inductive load.

TABLE F4  
TYPICAL DIAL READINGS

### TUBE SOCKET CONNECTIONS BOTTOM VIEW

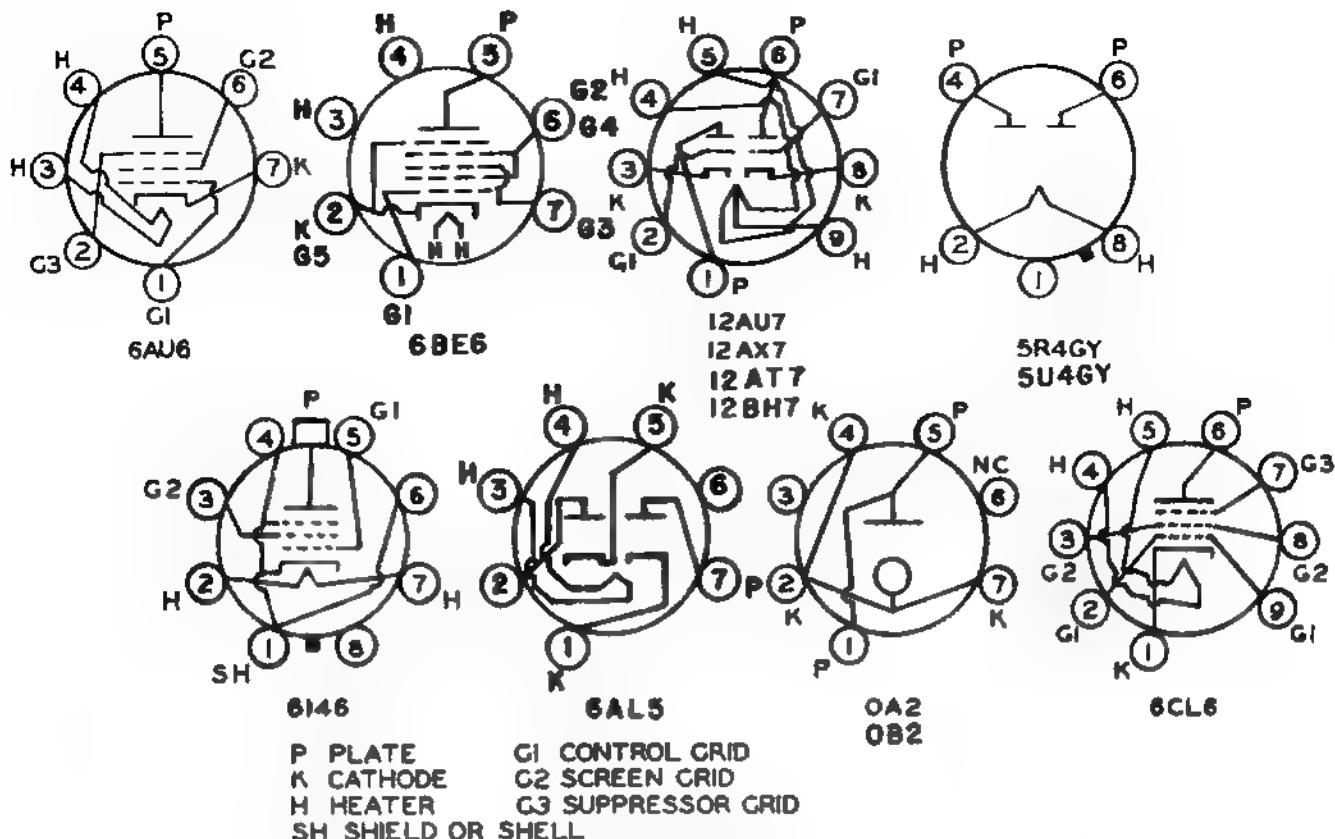


Figure 9a

#### CONDENSER-RESISTOR COLOR CODE

COLOR	SIGNIFICANT FIGURE	DECIMAL MULTIPLIER	TOLERANCE (%)	VOLTAGE RATING*
BLACK	0	1	10	100
BROWN	1	10	12	200
RED	2	100	33	300
ORANGE	3	1,000	44	400
YELLOW	4	10,000	55	500
GREEN	5	100,000	66	600
BLUE	6	1,000,000	77	700
VIOLET	7	10,000,000	88	800
GRAY	8	100,000,000	99	900
WHITE	9	1,000,000,000	10	1,000
COLD	-	0.1	10	2,000
SILVER	-	0.01	20	300
NO COLOR	-	-	-	-

\* APPLIES TO CAPACITORS ONLY



COLOR CODING OF FIXED RESISTORS

A-FIRST SIGNIFICANT FIGURE OF RESISTANCE IN OHMS

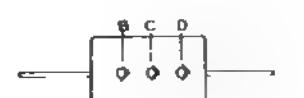
B-SECOND SIGNIFICANT FIGURE

C-DECIMAL MULTIPLIER

D-RESISTANCE TOLERANCE IN PERCENT IF NO COLOR SHOWN TOLERANCE IS  $\pm 20\%$ .



JAN FIXED CAPACITORS



RMA 3 DOT CODE 500VOLT  $\pm 20\%$

#### COLOR CODING OF FIXED CAPACITORS

A-TYPE MICA BLACK, PAPER SILVER

B-FIRST SIGNIFICANT FIGURE OF CAPACITY

C-SECOND SIGNIFICANT FIGURE

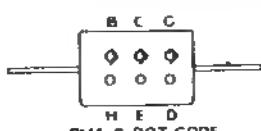
D-DECIMAL MULTIPLIER

E-TOLERANCE

F-CHARACTERISTIC

G-THIRD SIGNIFICANT FIGURE

H-VOLTAGE RATING



RMA 6 DOT CODE

Figure 9b

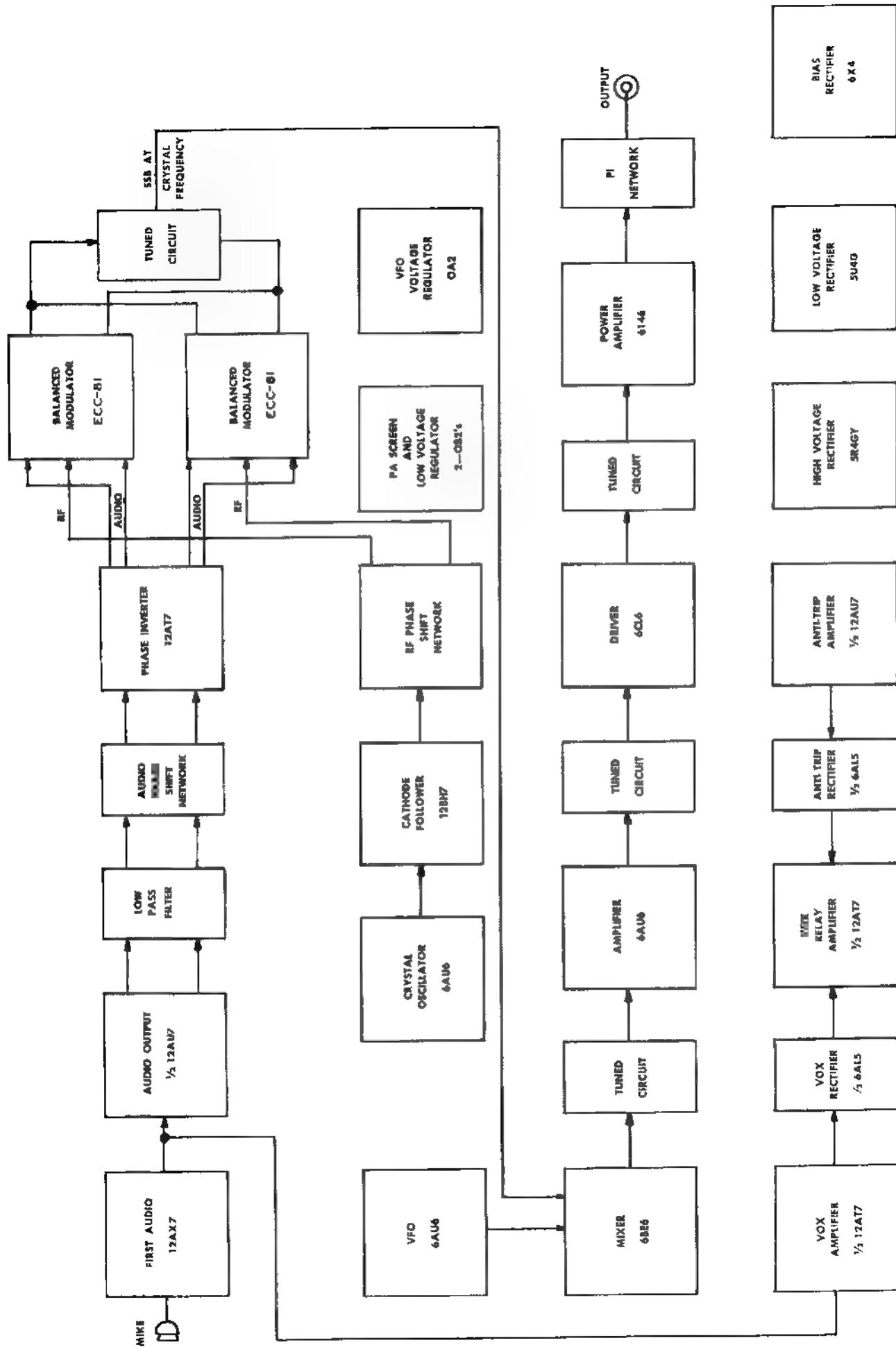


Figure 10: Pacemaker Block Diagram

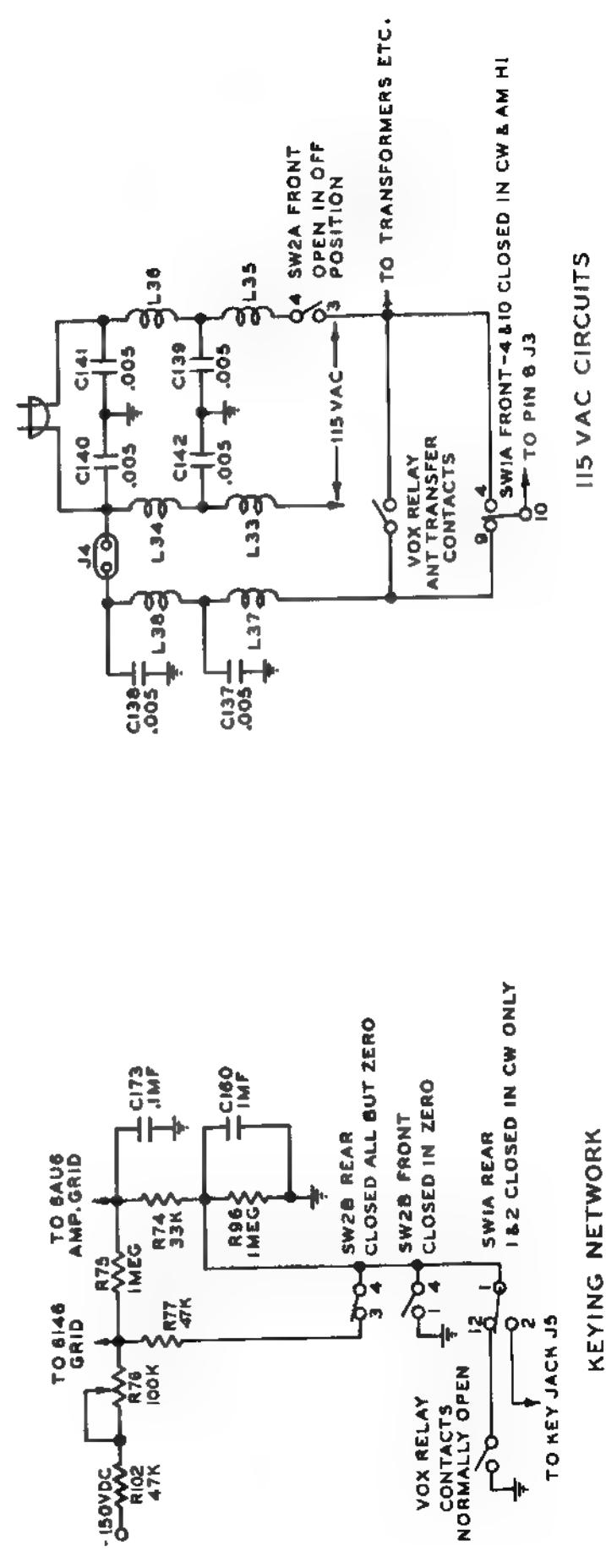
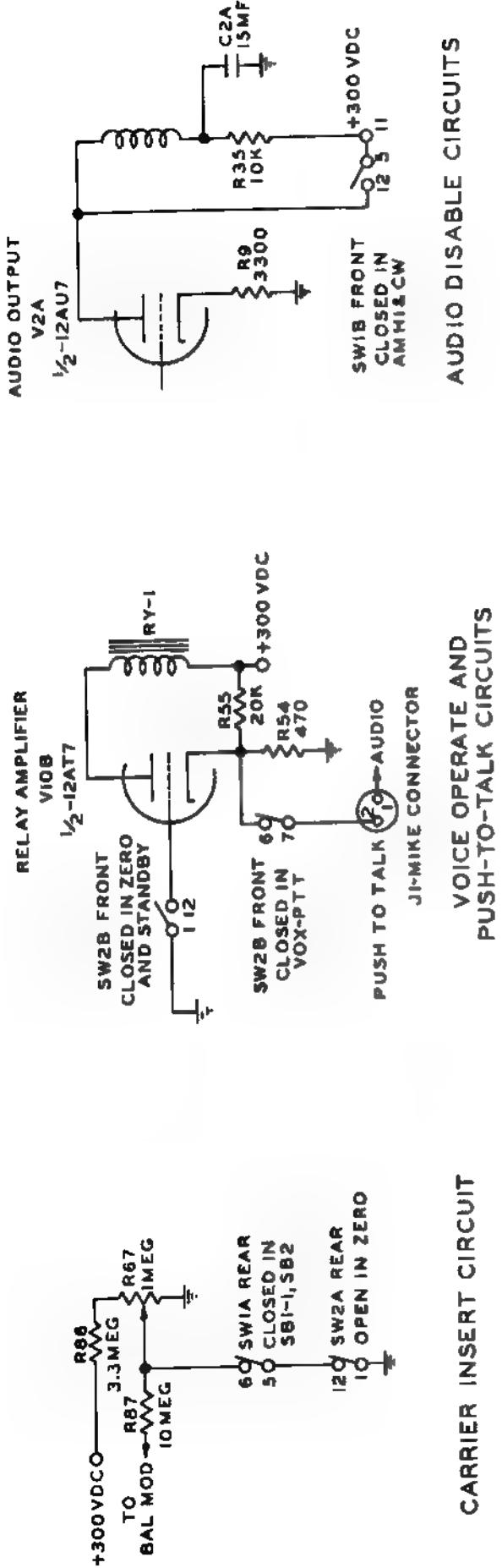


Figure 11: Simplified Control Circuits



Figure 7a: Meter Switch and Shield

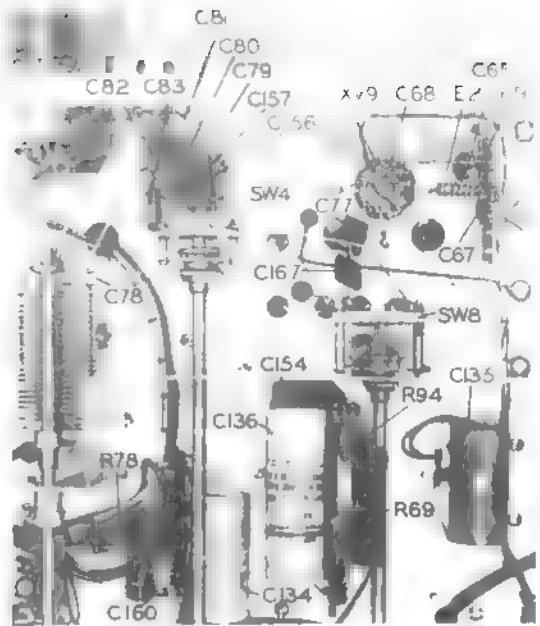


Figure 7b: Power Amplifier  
and H. V. Filter Section

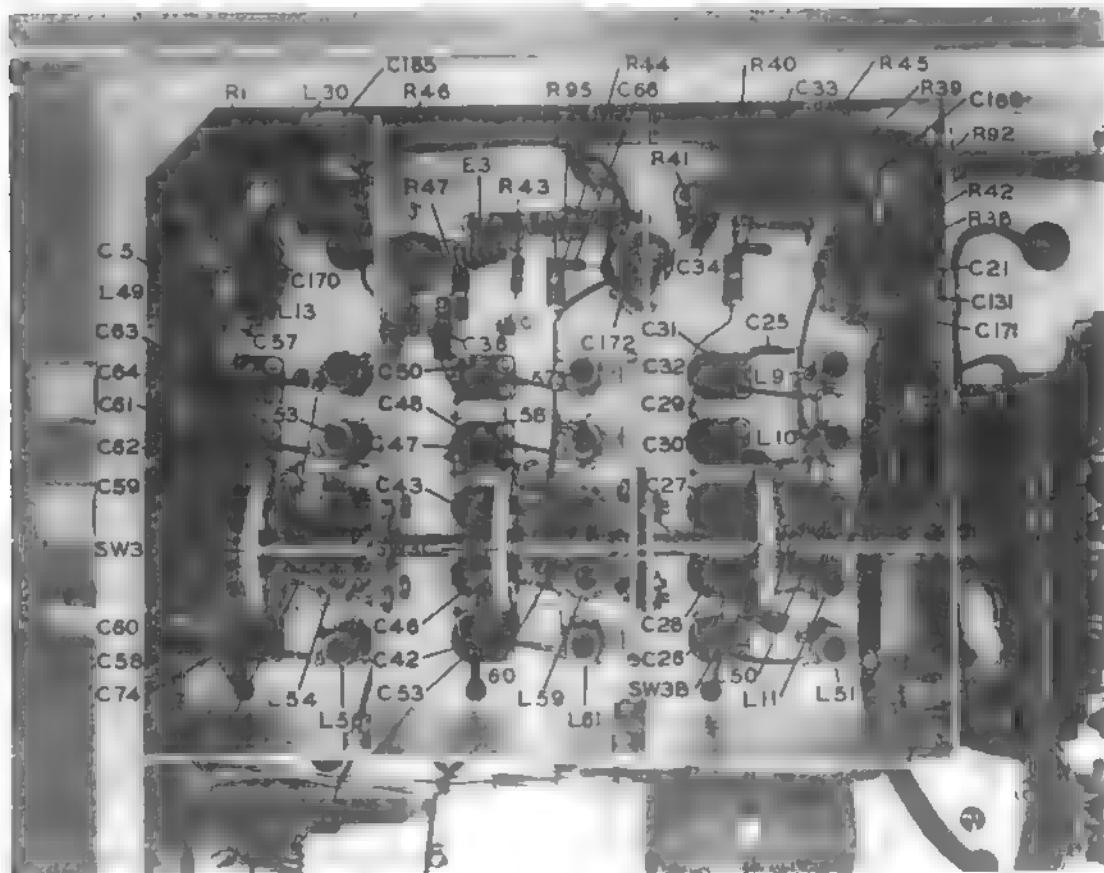
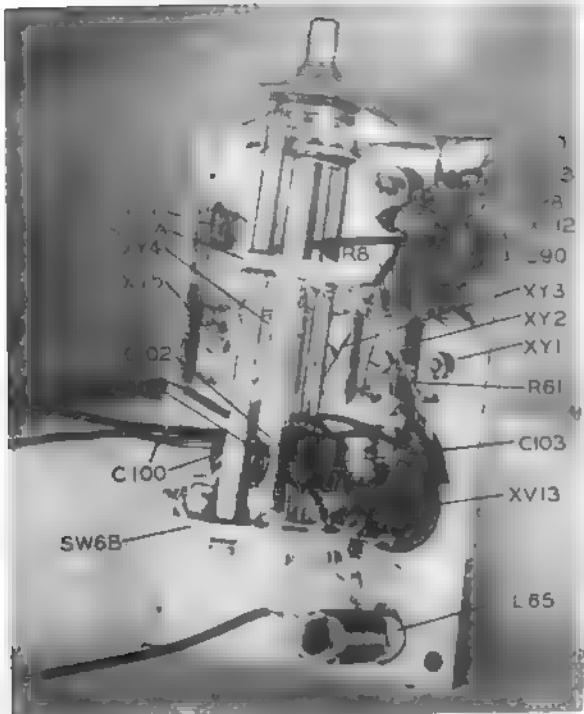
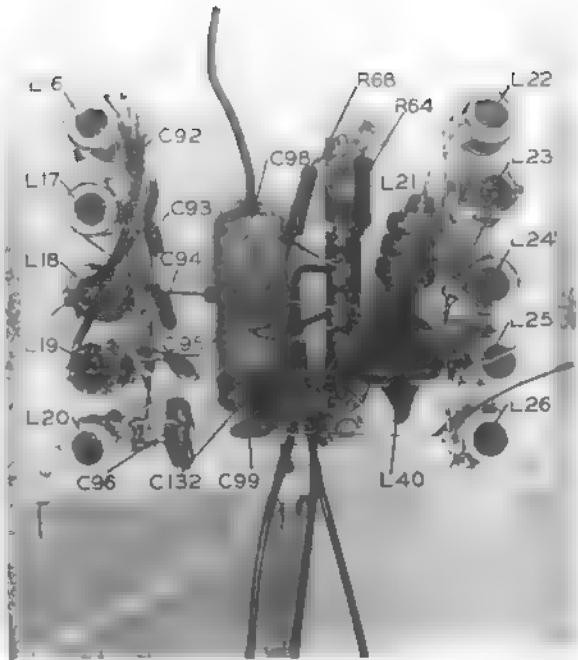


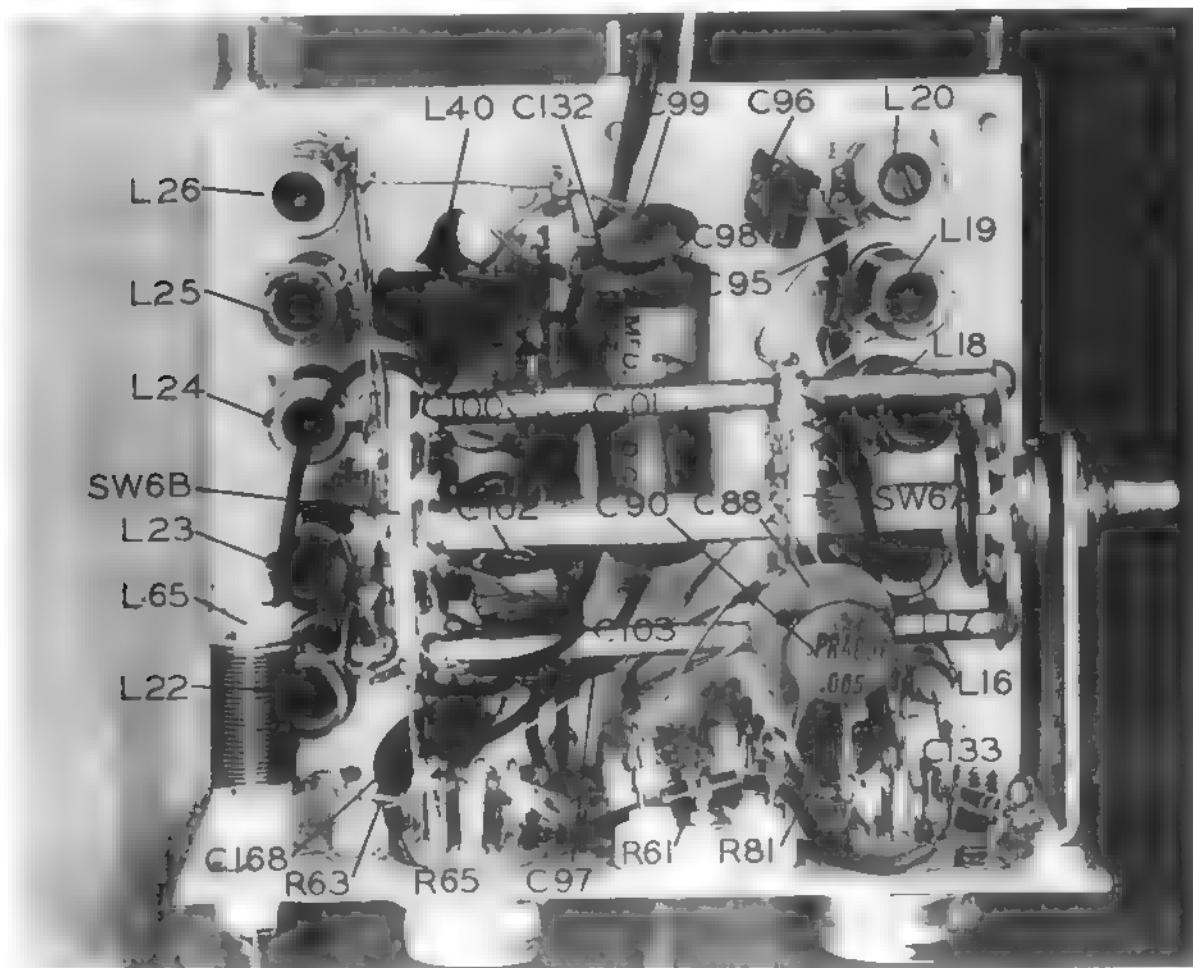
Figure 7c: RF Exciter, Bottom View



**Figure 8a: Crystal Oscillator  
Top Plate, Bottom View**



**Figure Bb: Crystal Oscillator Side Plate, Inside View**



**Figure Bc: Completed Crystal Oscillator Chassis**

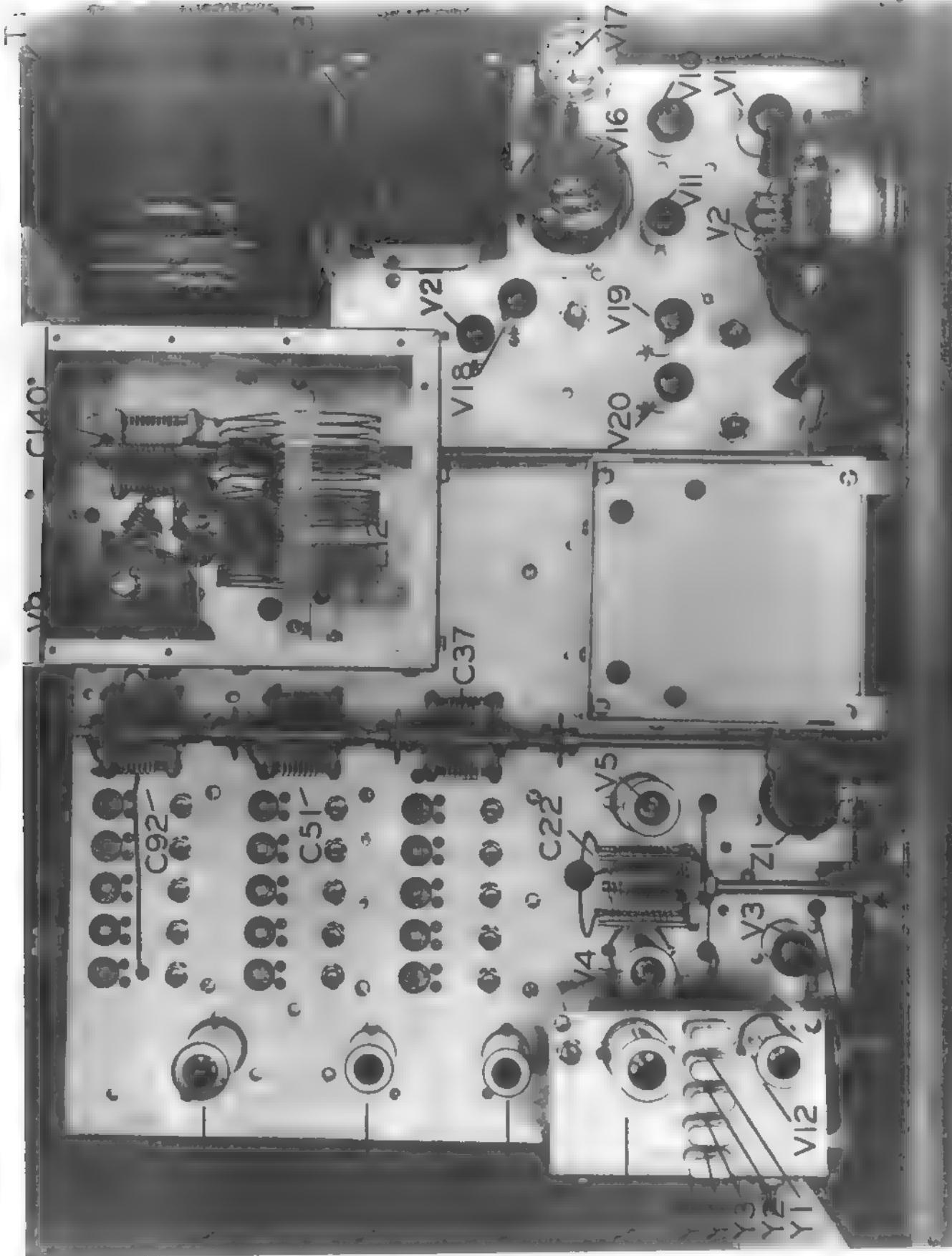


Figure 1: Completed Chassis, Top View

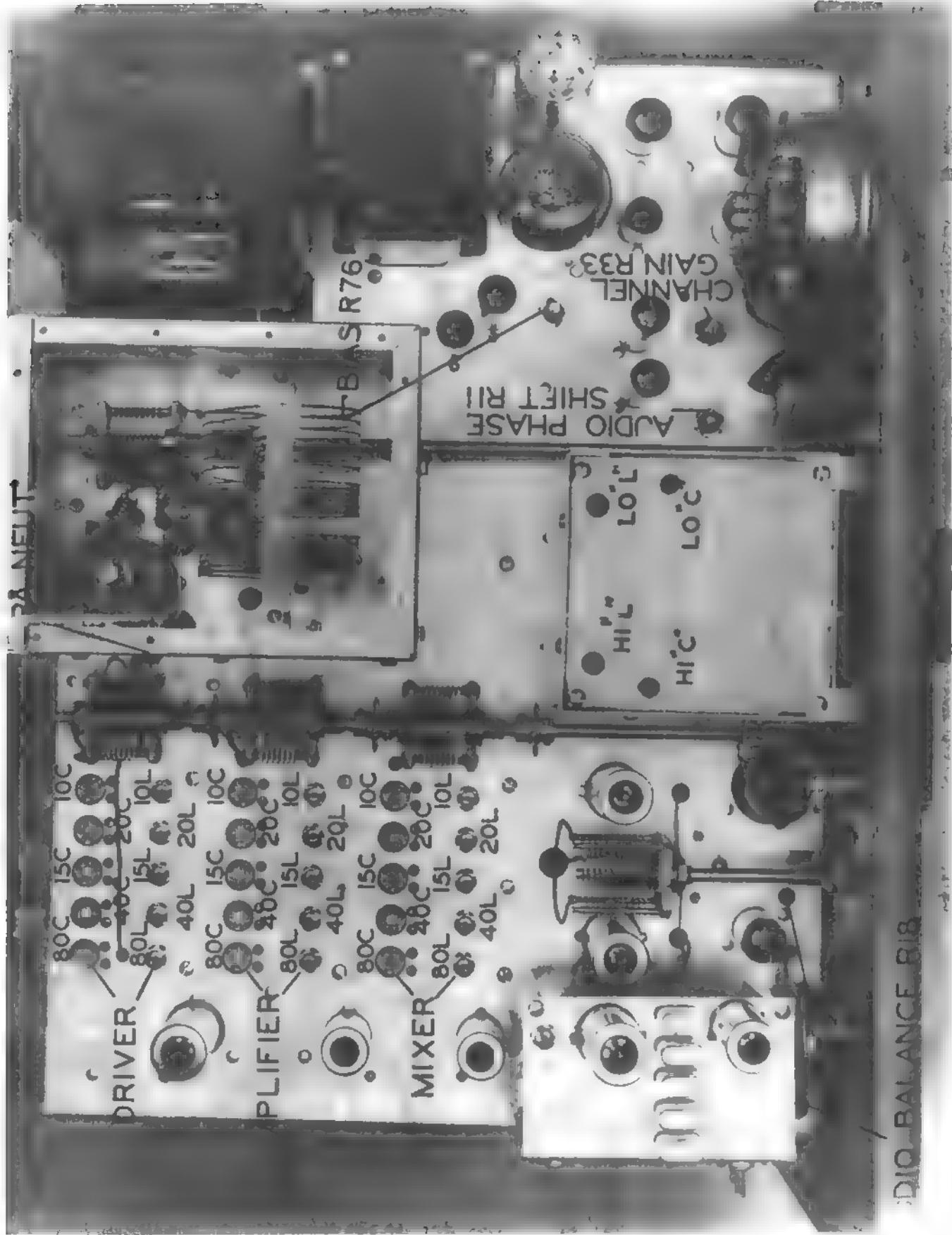
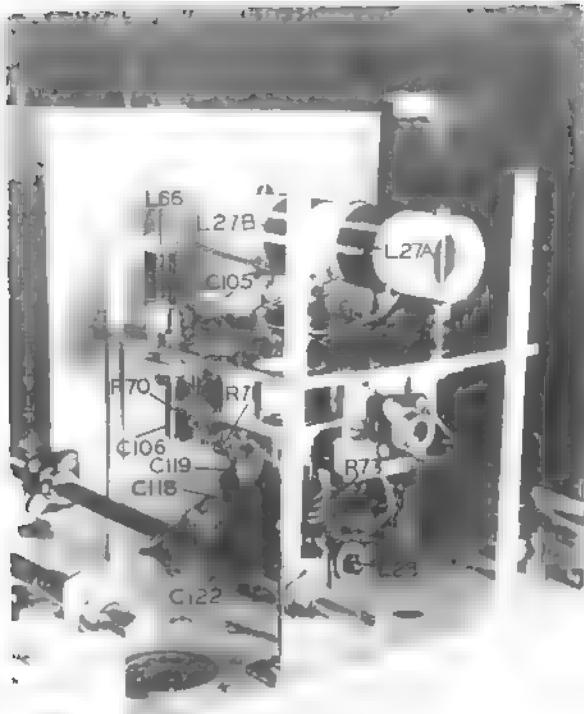
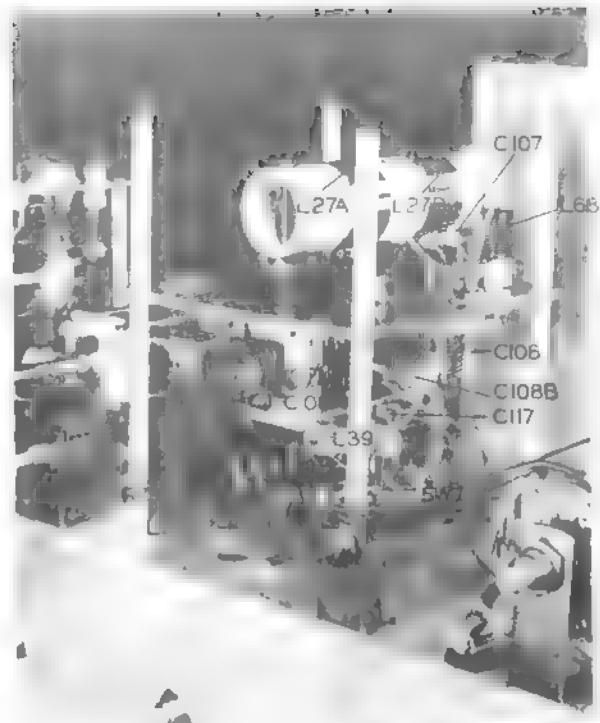


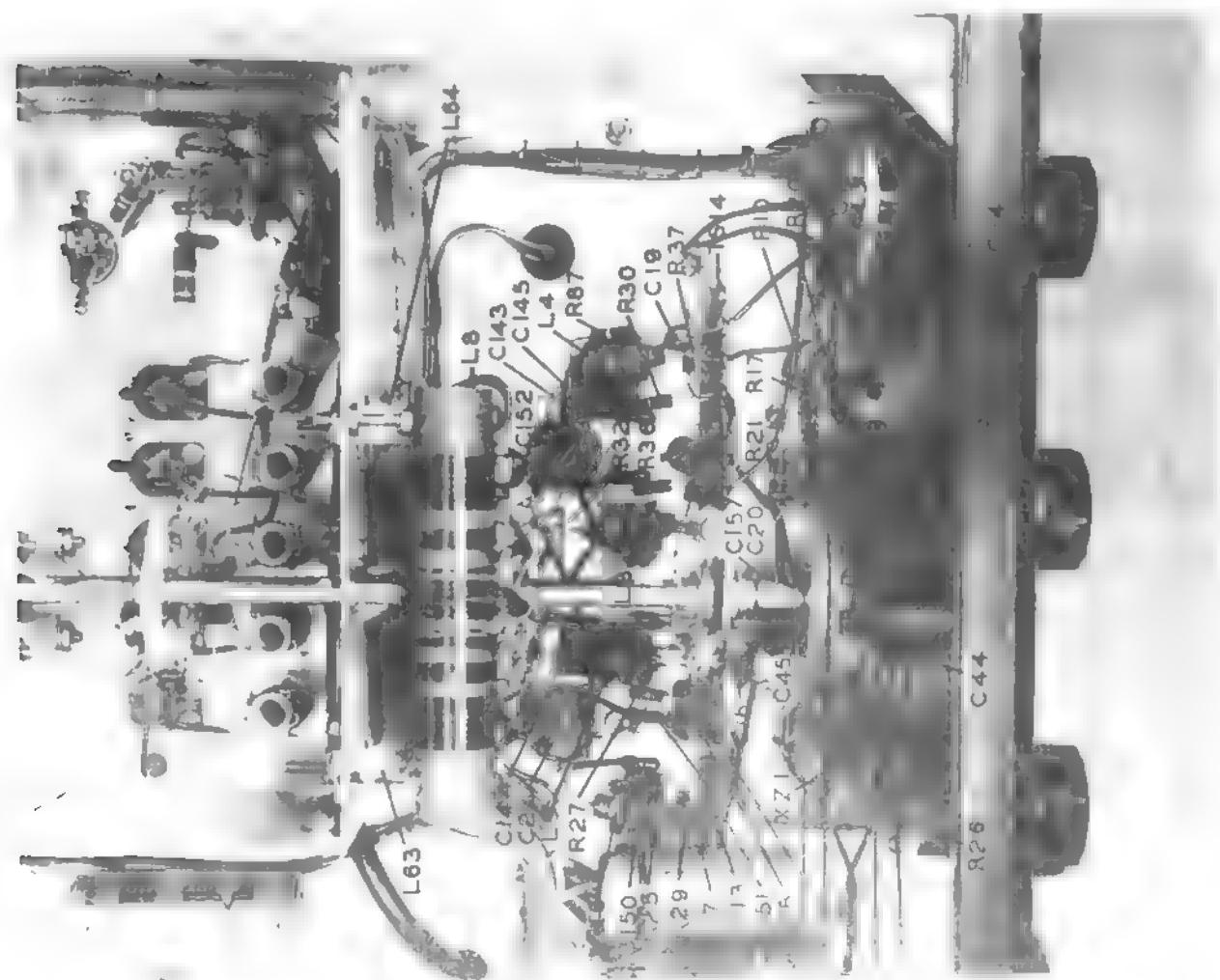
Figure 2: Chassis Adjustments, Top View



**Figure 5a: VFO, Left Side**



**Figure 5b: VFO, Right Side**



**Figure 5c: Balanced Modulator Section**

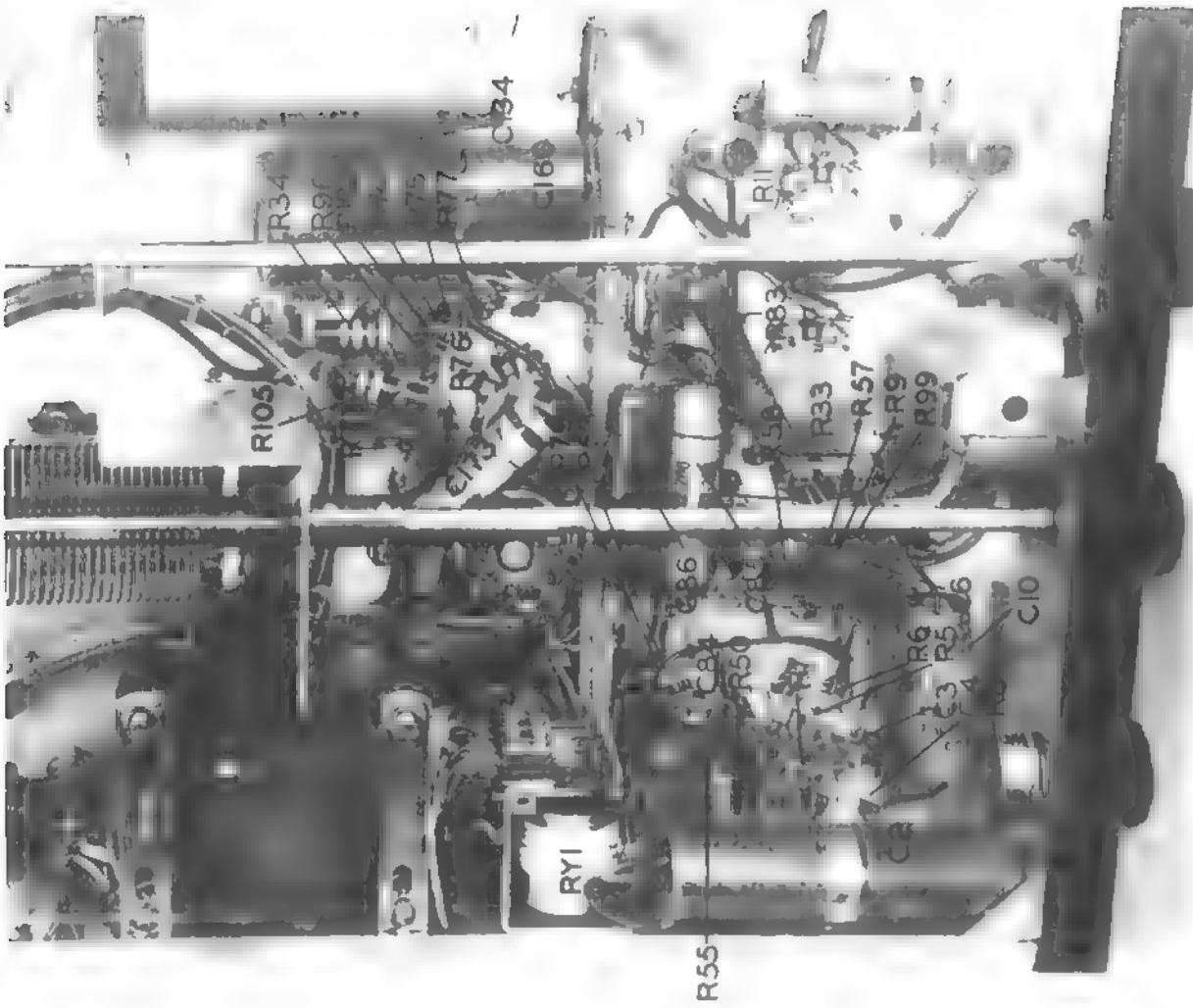


Figure 6c: Audio Section, Bottom View

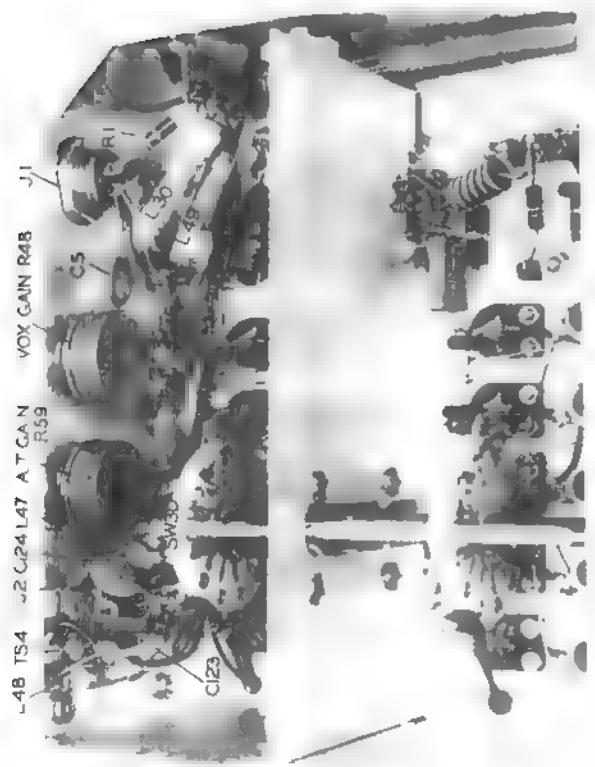


Figure 6a: Audio and Receiver Control Sockets

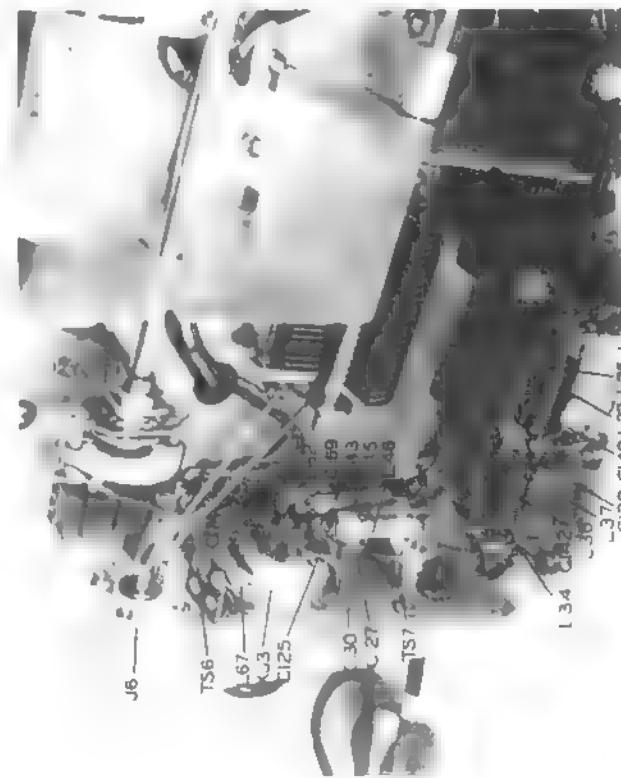


Figure 6b: Line Filter and Auxiliary Socket

# VIKING PACEMAKER TRANSMITTER

## Parts List

<u>Part No. or Drawing No.</u>	<u>Item No.</u>	<u>Qty.</u>	<u>Description</u>
17.955	CH1	1	Chassis
23.1128-2	CH2	1	Cabinet
23.1127-3	CH3	1	Panel
17.853-2	CH4	2	Chassis Rails
16.1322	CH25	1	Ground Connector, Chassis
17.957	CH6	1	Exciter Side Shield
17.959	CH7	1	No. 1 Exciter Shield
17.960	CH8	1	No. 2 Exciter Shield
17.956	CH9	1	Exciter End Shield
17.965	CH10	1	Crystal Oscillator Top Plate
17.964	CH11	1	Crystal Oscillator Side Plate
17.846-2	CH12	1	VFO Shield
17.961	CH13	1	VFO Top
17.819	CH14	1	VFO Side Plate
18.699-2	CH15	1	VFO Phenolic Plate
17.855	CH16	1	VFO Sub-Chassis
22.1182-2	CH17	1	Meter Shield Bracket
22.1181-2	CH18	1	Meter Shield Bracket
22.825	CH19	4	Bumper feet
17.974	CH20	1	P.A. Grid Shield
17.973	CH21	1	P.A. Grid Bottom Plate
71.43-097	CH22	65"	3/16 Rd. Metaltex Gasket
18.727	CH23	1	Capacitor Board
16.1001-5	B1	4	1 5/8" Component Bracket
16.1001-6	B2	5	1 3/8" Component Bracket
16.1001-4	B3	2	1" Component Bracket
16.1167-2	B4	6	VFO Capacitor Mounting Bracket
16.82-22	B5	2	Capacitor Mounting Board Bracket
23.1126	CH24	1	Final Coil Shield
23.1059	D1	1	Drive Arm, VFO Switch
14.515	D2	1	Drive, Cam, VFO Switch
23.1062	D3	1	Planetary Drive Assembly
17.858-3	D4	1	Dial Escutcheon
22.993-3	D5	1	Dial Plate
22.994	D6	26"	Rubber Gasket
22.995	D7	4"	Rubber Light Blocks
23.1064	D8	1	Dial Pointer
23.564-56	D9A, D9B	2	Red Jewels
23.907-22	D10, 11	2	100-0 Dial Knobs
23.1007-5	D12-21	10	Phenolic Knobs
23.980-12	D22	1	1 5/8" Band Knob
32.46-13	D23	1	2 3/8" Tuning Knob
23.1008	D24	2	Aluminum Knobs
13.123-12	D25	6	3/8-32 Panel Bearings
13.760-2	D26	1	Rigid Metal Couplings Less Set Screws
17.968	CH27	1	Final Coil Shield Top
16.82-24	B6	2	Bracket VFO Stiffening
16.86-1	D46	1	Tension Spring
104-264-2	D27	3	Insulated Couplings Less Set Screws
104-264-3	D28	1	Insulated Shaft Coupler Less Set Screws
13.49-9	D29	2	VFO Sub-Chassis Spacer

# VIKING PACEMAKER TRANSMITTER

## Parts List

<u>Part No. or Drawing No.</u>	<u>Item No.</u>	<u>Qty.</u>	<u>Description</u>
13.155-114	D30	2	11/16 Capacitor Mounting Post
14.31-64	D31	4	2 1/8 VFO Chassis Rod
14.31-65	D32	4	2 15/16 VFO Chassis Rod
14.31-68	D33	2	3 21/32 Crystal Osc. Chassis Rod
14.139-2	D34	1	6 7/16 Extension Shaft
14.139-5	D35	1	7 3/4 Shaft Extension
14.139-6	D36	1	12" Extension Shaft
18.638-2	D37	2	VFO Trimmer Shaft
13.864	D38	2	Dial Cord Post
23.909-1	D39	3	Dial Cord Pulley Outside Hub
23.909-2	D40	1	Dial Cord Pulley Inside Hub
29.405	D41	4	1/16 Capacitor Spacer
18.666-4	D42	2	Rigid Fiber Coupling Less Set Screws
14.31-67	D43	1	Final Coil Mounting Post
16.1027-1	D45	6	Dial Cord Springs
23.1047	XI <sub>2</sub> , XI <sub>3</sub>	2	Pilot Lamp Assistance
22.21	I <sub>1</sub>	1	S6, 110 VAC Pilot Lamp
22.377	I <sub>2</sub> , I <sub>3</sub>	2	#51 Pilot Lamp
22.837	TS8, 15, 21, 22, 24, 25, 26, 27, 6	9	2 Point Terminal Strip
22.740-3	TS5, 17, 18, 19, 23	5	3 Point Terminal Strip
22.740-4	TS4, 16, 7	3	4 Point Terminal Strip
22.740-5	TS1, 2, 3, 13	4	5 Point Terminal Strip
22.740-6	TS12, 20	2	6 Point Terminal Strip
22.740-7	TS9, 10, 11, 14	4	7 Point Terminal Strip
22.774	C79, 80, 81, 82, 118, 156, 157, 83	8	300 + 20% mmf 500 VW Molded Mica Capacitor
22.764	C2	1	15-15 mf 450 V Electrolytic Capacitor
22.1300	C3, 4	2	2000 mmf + 20% 600 VDC Ceramic Disc. Capacitor
22.827	C5, 24, 25, 34, 35, 56, 65, 68, 89, 90, 91, 131, 130, 132, 119, 120, 123, 124, 125, 127, 128, 137, 138, 139, 140, 141, 142, 146, 99, 163, 164, 169, 174, 175, 168, 176	36	.005 GMV mfd. 600 VW Ceramic Disc Capacitor
22.804	C111, 112, 115, 116	4	500 + 2% uuf 500 V Silver Mica Capacitor
22.1493	D46	3	Tube shield inserts, XV4, XV5, XV8
22.1097	C6, 13, 14, 15, 16, 21, 44, 45, 84, 87, 88, 170, 177	13	.01 + 20% Ceramic Disc Capacitor
22.768	C7, 8, 98, 173	4	1 mfd 400V Paper Tubular Capacitor
22.1184	C17, 18, 19, 20	4	.001 + 20% 600 V Disc Ceramic Capacitor
167.203-3	C22	1	50 uufd Butterfly Variable Capacitor
22.805	C23, 36, 57, 143	4	1000 mmf + 2% 500 V Silver Mica Capacitor

# VIKING PACEMAKER TRANSMITTER

## Parts List

<u>Part No. or Drawing No.</u>	<u>Item No.</u>	<u>Qty.</u>	<u>Description</u>
22.1130	C26, 27, 28, 30, 32, 42, 43, 46, 47, 50, 58, 59, 60, 62, 64	15	5-30 mmf Ceramic Variable Capacitor
22.4041-5	C29, 48, 61, 94, 97, 121	6	47 mmf + 5% 500 V Durmica Capacitor
22.4053-5	C150, 151, 152, 153	4	150 mmf + 5% 500 V Durmica Capacitor
22.1375	C77, 167	2	120 mmf + 5% 500 VW Silver Mica Capacitor
149-5-3	C37, 51, 72	3	100 mmf Variable Capacitor
22.4025-5	C39, 40, 53, 74, 92, 93	6	10 mmf + 5% 500 V Durmica Capacitor
22.4051-5	C31, 49, 63	3	120 mmf + 5% 500 V Durmica Capacitor
22.955	C70	1	.002 mfd 1500 V Mica Capacitor
149-6-3	C71	1	140 mmf Variable Capacitor
22.4049-5	C33, 66, 67, 95	4	100 mmf + 5% 500 V Durmica Capacitor
149-13-3	C78	1	360 mmf Variable Capacitor
22.1026	C85, 86	2	.22 mf + 20% 200 V Paper Tubular Capacitor
22.4029-2	C100	1	15 mmf + 2% 500 V Durmica Capacitor
22.4045-2	C101	4	68 mmf + 2% 500 V Durmica Capacitor
22.4156-2	C102	1	200 mmf + 2% V Durmica Capacitor
22.1186	C96	1	1200 mmf + 2% 500 V Silver Mica Capacitor
22.1240	C105	1	8.3 + .5 mmf Ceramic Capacitor
22.1241	C107	1	48 mmf + 2% Ceramic Capacitor
169-33	C108	1	Special Type L Capacitor
160-156-50	C166	1	5M30 Variable Capacitor
22.807	C117	1	43 uuf NPO Ceramic Capacitor
22.777	C122, 144, 145	3	25 mmf 500 VW 5% Silver Mica Capacitor
22.1187	C134	1	100 mf 250 V Electrolytic Capacitor
22.960	C110A, B	1	10-10MF 50 WV Electrolytic Capacitor
22.1298-1	C135	1	80 mf 450 V Electrolytic Capacitor
22.1387	C136, 154, 177	3	60 mf 450 V Electrolytic Capacitor
22.1224	C103	1	1750 uuf + 2% 500 V Silver Mica Capacitor
22.4061-5	C147, 148, 149, 1	4	330 mmf + 5% Durmica Capacitor
22.1189	C158	1	8 mf 400 V Electrolytic Capacitor
22.1216	C160	1	1 mf 200 V Electrolytic Capacitor
22.956	C69, 161, 162	3	.002 GMV 1500 V Disc Ceramic Capacitor
22.4033-5	C38, 52, 73, 41, 55, 76	6	22 mmf + 5% Durmica Capacitor
22.4018-5	C54, 75	2	5 mmf + 5% Durmica Capacitor
160-102-50	C165	1	5M11 Variable Capacitor
160-107-51	C106	1	15M11 Variable Capacitor
22.810	C171, 172	2	6.8 mmf + 2% 500 V Ceramic Capacitor
160-130-51	C104	1	30M8 Variable Capacitor
22.1132	C133	1	3 mmf Ceramic Capacitor
22.742	F1, 2	2	5A 250 V MTH Fuse
23.912-3	E1	1	Final Plate Suppressor
23.912-2	E2, 3	2	Final Grid 6CL6 Grid Suppressor
16.35-1	E4	1	Tube Cap
22.979	J1	1	2 Conn. Microphone Jack
22.1191	J2	1	4 Conn. Jack

# VIKING PACEMAKER TRANSMITTER

## Parts List

<u>Part No or Drawing No.</u>	<u>Item No.</u>	<u>Qty.</u>	<u>Description</u>
22.977	J3	1	9 Pin Octal Mica Filled Socket
126-105	J4, XY1, 2, 3, 4, 5	6	2 Pin Crystal Socket
22.980	J5	1	1 Circuit Key Jack
22.746	J6	1	83R-1 Coax. Connector
22.948-2	XJ3	1	Socket Support Shell
22.1214	K1	1	Voice Operate Relay
22.1192	L1, 2	2	26 MH Coil
22.1193	L3, 4, 5, 6, 13, 21, 28, 29, 40	9	2.4 MH Choke, 3 PI
23.1178	L8	1	110 uh Balanced Tapped Coil
23.1175-6	L9, 19, 52, 57	4	6.5 uh Coil
23.1175-7	L10, 53, 58, 65	4	1.26 uh Coil
23.1174	L12	1	11.5 uh Coil
102.752-4	L14	1	RFC
22.844-3	L15, 40	2	125 uh RFC
23.1175-5	L24, 68, 17	3	1.46 uh Coil
23.1175-2	L51, 56, 61	3	.29 uh Coil
23.1175-1	L23, 16	2	1 uh Coil
23.1180	L26, 39, 20, 63, 64	5	55 uh Universal Wound Coil
23.1179	L27	1	VFO Coil 49.9 - 43 uh
23.1000	L43, 44, 45, 46, 47, 48, 49, 62, 30, 67	10	
23.1175-15	L66	1	4.7 uh RFC
23.1175-16	L25	1	2.75 uh Coil
22.1213	L31	1	4.1 uh Coil
22.1212	L32	1	10H HV Choke
23.1175-3	L50, 55, 60	3	15H LV Choke
23.1175-8	L22	1	.69 uh Coil
22.1167	M-1	1	.5 uh Coil
22.1190	P1	1	0-1 ma Meter
22.978	P2	1	4 Pin Plug
22.981	P3	1	9 Pin Octal Plug
23.1031	P4	1	2 Pin AC Male Plug
22.5065-10	R1, 21, 22, 36, 37, 23, 24, 28, 29	9	2 Pin Plug
23.1175-4	L11, 54, 59	3	4700 ohm 1/2 W Resistor
23.1175-17	L18	1	1.26 uh Coil
22.5121-10	R2, 17, 19, 25, 27, 30, 32, 75, 87, 96, 100, 101	12	2.0 uh Coil
22.5041-10	R3, 54, 58	3	1 megohm 1/2 W Resistor
22.5105-10	R4, 7, 50, 57	4	470 ohm 1/2 W Resistor
22.5113-10	R5	1	220 K ohm 1/2 W Resistor
22.1195	R8, 48, 59, 67	4	470 K ohm 1/2 W Resistor
22.5089-10	R10, 20, 36, 37, 77, 80, 102	7	1 megohm 1/4 W Log Taper Potentiometer
22.1194	R11	1	47K ohm 1/2 W Resistor
22.5061-10	R6, 9, 49	3	500 ohm Linear Potentiometer
			3300 ohm 1/2 W Resistor

# VIKING PACEMAKER TRANSMITTER

## Parts List

<u>Part No. or Drawing No.</u>	<u>Item No.</u>	<u>Qty.</u>	<u>Description</u>
22.832	R18	1	1 megohm Linear Potentiometer
22.1196	R26, 31	2	2000 ohm 1/4 W Linear Potentiometer
22.1115	R33, 91	2	100 K Linear Potentiometer
22.6049-10	R105	1	1000 ohm 1 W Resistor
22.5073-10	R35, 45, 52, 90, 91, 92, 93, 105, 106	9	10 K ohm 1/2 W Resistor
22.5081-10	R38	1	22 K ohm 1/2 W Resistor
22.7079-10	R39, 46, 73	3	18 K ohm 2 W Resistor
22.6065-10	R40, 44	2	4700 1 W Resistor
22.5097-10	R41, 43, 51, 56, 60, 63, 70, 61	8	100 K ohm 1/2 W Resistor
22.6033-10	R47	1	220 ohm 1 W Resistor
22.5029-10	R81	1	150 ohm 1/2 W Resistor
22.5047-10	R65	1	820 ohm 1/2 W Resistor
22.1099	R55	1	20 K ohm 10 W Resistor
22.5049-10	R62, 84	2	1000 ohm 1/2 W Resistor
22.1199	R64, 68	2	220 + 1% ohm 1/2 W Deposited Carbon Precision Resistor
22.8908	R69, 94, 103	3	15 K 10 W Resistor
22.5019-10	R71	1	56 ohm 1/2 W Resistor
22.5053-10	R72, 82	2	1500 ohm 1/2 W Resistor
22.5085-10	R74	1	33 K 1/2 W Resistor
22.7089-10	R34	1	47K ohm + 10% 2 W Resistor
22.5129-10	R53, 79	2	2.2 megohm + 10% 1/2 W Resistor
22.7063-10	R78	1	3900 ohm 2 W Resistor
22.1032	R83	1	3000 ohm 10 W Resistor
22.8018-5	R85	1	.51 ohm + 5% 1/2 W Resistor
22.5145-10	R87	1	10 megohm 1/2 W Resistor
22.5045-10	R89, 42	2	680 ohm 1/2 W Resistor
22.5083-10	R95	1	27 K ohm 1/2 W Resistor
22.1173	SW1	1	Emission Switch, 5 pos., 2 steat. wafer
22.1174	SW2	1	Operate Switch, 5 pos., 2 steat. wafer
22.1175	SW3	1	Exciter Bandswitch, 5 pos., 4 steat. wafer
22.1176	SW4	1	Auxiliary Loading Switch, 7 pos., 1 steat.wafer
22.1177	SW5	1	Meter Switch, 2 pos., 1 phen.wafer
22.7081-10	R104	1	22K ohm 2 W Resistor
22.5133-10	R86	1	3.3 Megohm 1/2 W Resistor
22.1178	SW6	1	Crystal Oscillator Bandswitch 5 pos., 2 steat. wafer
22.1179	SW7	1	VFO Bandswitch, 2 pos., 1 phen wafer
22.1180	SW8	1	Final Bandswitch, 5 pos., 1 steat. wafer
22.1217	T1	1	21 K 600 ohm Audio Transformer
22.1211	T2	1	Power Transformer
22.1203	V3, 10	2	12AT7 Tube
22.1204	V6	1	6BE6 Tube
22.780	V7, 12, 14	3	6AU6 Tube
22.1118	V8	1	6CL6 Tube
22.788	V9	1	6146 Tube
22.786	V11	1	6AL5 Tube
22.1205	V13	1	12BH7 Tube

## VIKING PACEMAKER TRANSMITTER

## Parts List

<u>Part No. or Drawing No.</u>	<u>Item No.</u>	<u>Qty.</u>	<u>Description</u>
22.787	V15, 21	2	OA2 Tube
22.784	V16	1	5R4GY Tube
22.1104	V17	1	5U4G Tube
22.1206	V19, 20	2	OB2 Tube
22.916	V2	1	12AU7 Tube
22.915	V1	1	12AX7 Tube
22.1203-2	V4, 5	2	ECC-81/12AT7 Tube
22.1366	V18	1	6X4 Tube
22.976	XV1, 2, 3, 10	4	9 Pin Miniature Tube Socket
22.1207	XV4, 5, 8, 13	4	9 Pin Shielded Miniature Tube Socket
22.1208	XV6, 7, 12	3	7 Pin Shielded Miniature Tube Socket
22.849-2	XV9, 16, 17		
	X2-1	4	Octal Socket
22.975	XV11, 14, 15, 18, 19, 20, 21	7	7 Pin Miniature Tube Socket
22.1209-1	Y1	1	500 KC Fundamental Crystal
22.1209-2	Y2	1	4 MC Fundamental Crystal
22.1209-3	Y3	1	11 MC Fundamental Crystal
22.1209-4	Y4	1	18 MC Overtone Crystal
22.1209-5	Y5	1	25 MC Overtone Crystal
23.631	XI1	1	Candelabra Screw Base
23.1181	W1	1	Harness
22.1210-1	W18	27	EE 5005 Iron Slugs
22.1210-2	W19	3	EE 5006 Iron Slugs
42.49-148	W20	6 ft.	Dial Cord
71.49-114	W22	7 ft.	Black Line Cord 18-2 POSJ
22.1218-1	XS4, 5, 8, 13	4	9 Pin Tube Shield
22.1218-2	XS6, 7, 12	3	7 Pin Tube Shield
250-32	Z1	1	Phase Shift Network
1 Envelope			#4 Hardware
1 Envelope			#6 Hardware
1 Envelope			#8 Hardware
1 Envelope			#10 Hardware
1 Envelope			Miscellaneous Hardware
1 Envelope			Set Screws
1 Envelope			Solder Lugs, Spade Lugs, Grommets
11.951-13 7/8		4	10-24 NPS Trus Head Tie Bolts-13 7/8" Long
1 Box			Miscellaneous Wire and Tubing
22.1493	WO		Inserts, Tube Shield, XS4, XS5

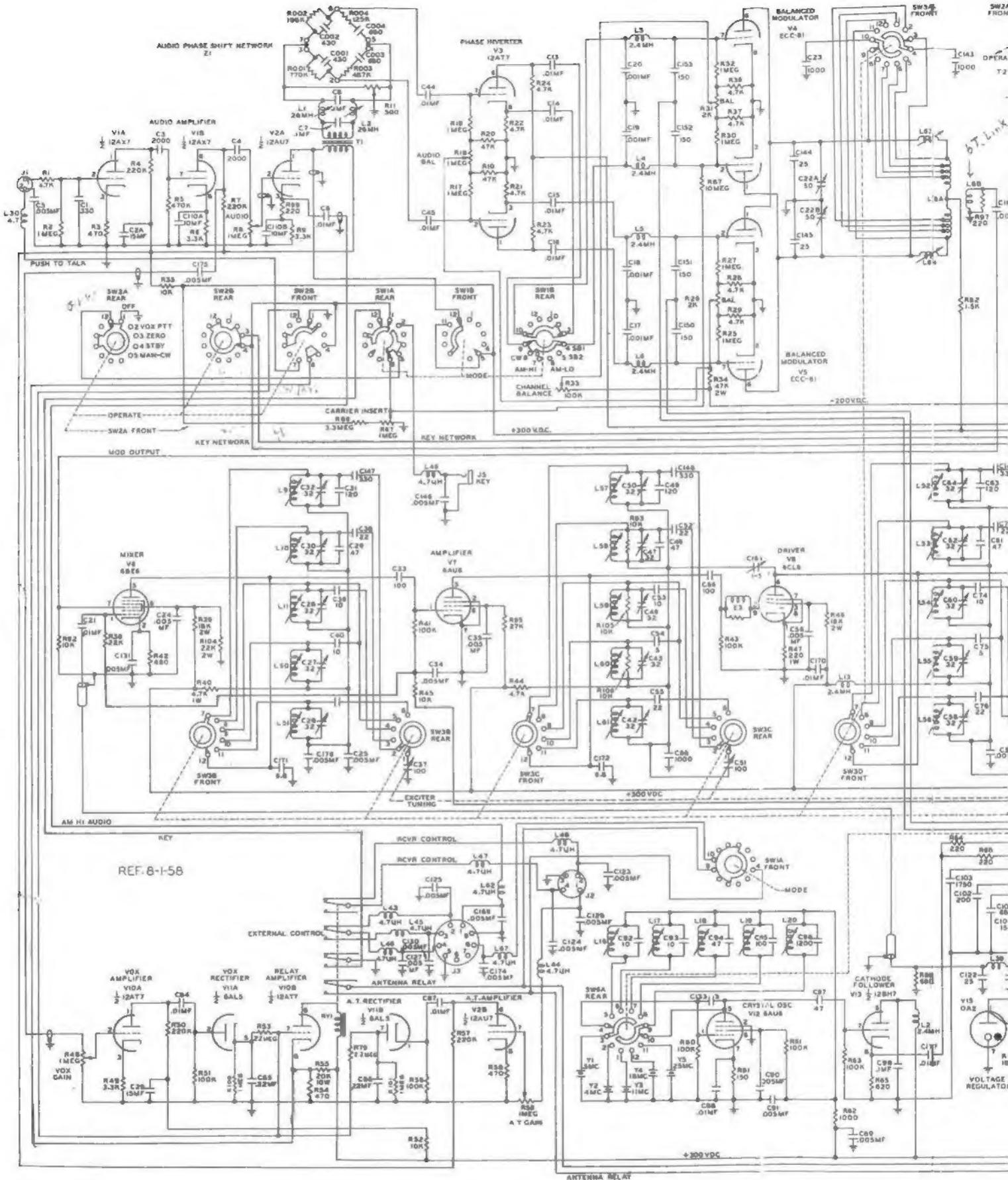


Figure 12: Pacemaker Schematic Diagram

